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ABSTRACT

Following discussions of Oklahoma aerospace history and the history of flight, interdisciplinary aerospace activities are presented. Each activity includes title, concept fostered, purpose, list of materials needed, and procedure(s). Topics include planets, the solar system, rockets, airplanes, air travel, space exploration, principles of flight, kites, air motion/pressure, satellites, and others. Activities include: (1) completing vocabulary exercises, word searches, crossword puzzles, etc.; (2) performing simple science experiments; and (3) completing various art and mathematics activities related to a given topic. A glossary of key words, list of instructional aids, and evaluation sheet are included in an appendix. (JN)

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HIGH FLIGHT

Aerospace Activities

K-12

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HIGH FLIGHT

Aerospace Activities

Oklahoma
State Department of Education
1982

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FOREWORD

The Aerospace Education Committee appointed by Governor George Nigh has provided continuing leadership in developing a program in aerospace education in the public schools of Oklahoma. They have given impetus and encouragement for Aerospace workshops, in-service education, and the production of this curriculum guide.

We all recognize the great and growing interest in aviation and aerospace and the important position held by these industries in the economic life of Oklahoma. Our schools, to be relevant now and in the future, must have a curriculum developing the realities of aviation and space. In meeting this challenge, I commend the Oklahoma educators on their initiative and imagination in the development of this guide. This booklet should help teachers prepare the students who are in school today for the responsibilities of citizenship in an aerospace age.

The State Department of Education gratefully acknowledges the contributions of the State Committee and Subcommittees of the Oklahoma Curriculum Improvement Commission for their support in this endeavor.

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UP, UP, AND AWAY

AEROSPACE HISTORY

AND

ACTIVITIES

OKLAHOMA
AEROSPACE HISTORY

An account of the history of aviation in Oklahoma plays like a leisurely walk through Oklahoma's new Air Space Museum which is an integral part of the Kirkpatrick Center, 2100 N.E. 52nd Street, Oklahoma City. Of course, it's hard to be leisurely about anything as fast paced as aviation has been in our state. Even during the earliest days there was flying activity in the Sooner State.

Oklahoma and aviation grew into being together. Our state has always been a leader in the development of aviation, not only in the military aspect, but also in commercial and private flight, both scheduled and civilian, as well as agricultural aviation. Add to the numerous types of planes in the air all of the related aspects of aviation and you have a vast industry.

Just seven years after the famous flight by the Wright brothers and three years after Oklahoma became a state, Oklahomans witnessed the first flight in Oklahoma. It was performed on March 10, 1910, by the barnstorming pilot, Charles F. Willard, over what is now the Capitol Hill area of Oklahoma City. He flew a fabric-covered biplane, nicknamed The Butterfly, for a distance of 500 yards at an altitude of 75 feet.

In the fall of that same year, the first known air circus in Oklahoma was held at the old fairgrounds in Oklahoma City. Fifteen pilots participated in the event.

In 1911, Clyde Cessna devoted much of his time to flying and giving lessons in his home-made Bleriot-type plane over the Salt Plains area near Cherokee, Oklahoma. His interest and devotion to aircraft led to the establishment of the Cessna Aircraft Company in Wichita, Kansas.

That same year in the Nichols Brothers Bicycle Shop in Chickasha, Oklahoma's first airplane was built. It was piloted by Lestere Miller who gave it the name "Albatross." Miller was issued a permit by the government on October 13, 1913, to carry U.S. mail.

In 1915 the first military airlift squadron was organized in southwest Oklahoma. It flew from Ft. Sill in Lawton to Ft. Sam Houston in San Antonio, Texas.

The first commercial aircraft production began in 1917 at Dewey, Oklahoma, on land donated by Joe Bartels. It was here that the Curtis Jenny flight trainer was built which was to play an important part in training pilots. W.D. (Billy) Parker spent considerable time here developing his controllable pitch propeller which increased the efficiency of all later aircraft.

Frank Champion of Oklahoma City flew as early as 1917 in a Moisant monoplane which was a copy of the French Bleriot. He later became both nationally and internationally known for his exhibition flying which included breath-taking loops as well as other previously unknown maneuvers.

It was also in 1917 that the first commercial airport was built in Oklahoma City by Bennett Griffin and Mark Adams. These men were instrumental in the growth of commercial traffic in Oklahoma which by 1928 led to a total of 42 airfields in our state.

Prior to World War I, activity began to increase. Many Oklahomans joined the Signal Corps and learned to fly. By the end of the war, names like B.S. (Cheebee) Graham, Col. Bill Bleakley, Clarence E. Page, Burrell Tibbs, Jimmy Hazlip, and W.D. (Billy) Parker were well-known as outstanding pilots.

Then came the barnstormers. WW I surplus trainers were available for $300 apiece and they were quickly sold to former pilots who recognized the opportunity to continue flying. These pilots would land in cow pastures, and for a small fee, take passengers for short rides. They also performed dare-devil feats for the crowds who gathered in the fields below.

Clarence E. Page, first president of the Oklahoma Air Space Museum, describes these barnstorming days as follows: "We didn't make any money, but we liked what we were doing--turning handsprings for hamburgers."

Aviation made great strides throughout the country during the twenties. Perhaps the most noteworthy flight was made by Charles Lindbergh on May 21 and 22, 1927, when he flew non-stop from Mineola, N.Y., to Paris, France, a total of 3,610 miles in the record time of 33 hours, 29 minutes and 30 seconds. This flight gave spark to what was to be known as the golden age of aviation.

The expansion of the oil industry in Oklahoma was instrumental in the growth of the aviation industry. Better and swifter transportation was needed and the oil companies had money to invest in this new mode of transportation for their employees.

W.D. (Billy) Parker, sponsored by Phillips Oil Company, did barnstorming exhibitions for several years in two aircraft that he built in the 1920s. Replicas of the 1912 and 1914 Curtiss Pusher planes are now on exhibition in Oklahoma City's Will Rogers World Airport and in the Tulsa International Airport.

Many oil companies sponsored pilots in air races. Frank Phillips of the Phillips Petroleum Company in Bartlesville, donated the plane flown by Arthur Goebel in 1927 from Oakland, California, to Honolulu, to win the Dale Race award. His plane was named the Woolaroc and it is now proudly exhibited in the Woolaroc Museum in Bartlesville.

Tom Braniff of Tulsa, who co-owned a Stinson-Detroiter with E.E. Westervelt, realized the possibility of flying passengers between Oklahoma City and Tulsa. These cities were rapidly growing communities and were the centers of oil development and industry in Oklahoma. His brother, Paul Braniff, a pilot in WW I, was his ticket seller and pilot. So, on June 20, 1928, the first commercial passenger flight was made. The demands for this service grew and later became known as Braniff Airways, the first airline in the Southwest United States.

Earl Halliburton, another pioneer in the aircraft industry, established the Southwest Fast Air Express, later known as the American Airlines.

For five eventful years, until the depression took its toll, the aircraft industry progressed from one major development to another.

The Lindberg line of TAT was routed through Oklahoma which even then was recognized as a major airline transportation center. Air cargo was faster and more economical than comparable surface shipment by truck or train.

While the entire country was in the gloom of the depression of the '30s, a famous Oklahoma Cherokee Indian, Will Rogers, met Wiley Post. This eventful meeting took place in Tulsa and was arranged by Charlie Short, manager of the Tulsa Airport, and Morton Harrison. Post and Rogers became close friends through their mutual interest in aviation, and their enthusiasm for flying was conveyed to the entire nation.

Wiley Post of Oklahoma City saw his first airplane, an old Curtiss Pusher, at a county fair near Rush Springs when he was 15 years old. His love for airplanes never wavered. He made many contributions to aviation besides his record-setting flight in 1931. Because of his many long solo flights, he saw a need for some method of automatic control. This led to his invention of the Sperry Automatic Pilot device. He was also the first to use the radio direction finder, a form of which is still in use in today's aircraft.

Wiley Post, believing that more efficient flying could be accomplished at higher altitudes, decided to develop an oxygen-carrying pressurized suit in order to withstand the environment of high altitudes. In December of 1934, wearing a rubber and metal "space suit" with its own oxygen generator, Post flew the "Winnie Mae" at an altitude of

50,000 feet over Oklahoma. During this flight he experienced for the first time the effects of the jet stream, now used by most commercial airplanes. This suit was also the forerunner of the space suits used by today's astronauts.

The depression caused a public apathy which resulted in a lag in the development of aviation. This general attitude prevailed until the conditions in Europe made our nation conscious of the possibility of WW II.

Oklahoma was destined to play an important role in the ultimate victory of WW II.

The history of Tinker Air Force Base began on April 8, 1941. It was on that date that the War Department notified Oklahoma City of its selection as a site for a centrally located supply and maintenance depot.

Events moved swiftly and by July the first spade of earth in a hayfield nine miles southeast of Oklahoma City had been turned for construction of the depot. Earlier, a group of farsighted businessmen and civic leaders had offered 960 acres of land to the War Department. This became the original site of what is now Tinker Air Force Base and Oklahoma City Logistics Center.

On March 1, 1942, the War Department activated the base as the Oklahoma City Air Depot, and a long and colorful role in the nation's military was well underway.

With Pearl Harbor still a fresh memory, Tinker Air Force Base, as it was later named, was to play an immediate and important role

throughout WW II. The base was named for Maj. Gen. Clarence L. Tinker, a native Oklahoma Indian, who lost his life on June 2, 1942, while leading his bomber command on a strike against the Japanese at Wake Island.

During the war, Tinker's industrial plant repaired B-24 and B-17 bombers, and fitted B-29s for combat.

Following the end of the war, expansion began with the annexation of the Douglas Aircraft Company Maintenance Center. With this new acquisition, the base became one of the largest depots in the continental United States.

In 1947, jet engine overhaul was added to the base's mission and the Air Force became a separate entity.

In the early 1950s, Tinker had become a strategic center for the fast developing all-jet Air Force. The outbreak of hostilities in Korea placed new demands on the base for speedy maintenance and repair of aircraft including the B-52 and KC-135, as well as engines and accessories for aircraft employed in the conflict.

During the past decades, Tinker assumed many new roles and grew in importance as it contributed significantly to national defense. Today, after 40 years, Tinker has grown into Oklahoma's largest industry and is considered to be one of the major military industrial installations in the world.

Clarence E. Page, one of the leaders in the history of Oklahoma aviation, has had a long and varied career. From the early days when he witnessed the first airplane flight over Oklahoma City, until today at the age of 85, his life has revolved around the aviation industry. He, along with many other Oklahoma pilots such as O.M. (Red) Mosier, became a military pilot during WW I.

During the barnstorming years following WW I, Page maintained his interest in flying. According to Page, "I knew everybody in aviation--including all of the 'greats' of the golden era of flying. Even if they weren't Oklahomans, they all passed through Oklahoma." And Page did know them all!

In 1931, B. S. "Cheebie" Graham and Clarence Page were issued the first two Transport Pilot's licenses. Page later assisted men like Bennett Griffin and Jimmy Mattern establish four world flight records.

During WW II, Page was responsible for the training of almost 9,000 pilots.

After the war, Page decided to stay in aviation and become a War Assets Agent, warehousing and selling aircraft parts for the government.

Page Aircraft Maintenance, Inc., soon became one of the top defense companies in the United States. Page continued in the business until 1972, until at the age of 75, he felt it was time to retire. The thriving military contract maintenance company was then sold to the Northrup Corporation.

Since 1972, because of his strong pride in early Oklahoma aviators, as well as all those who later became famous, such as Oklahoma's astronauts, Page has developed one of the finest aviation space museums

in the country. The Oklahoma Aviation and Space Hall of Fame and Museum is a tribute to Clarence E. Page and he is it's main supporter, both physically and financially.

We owe a never-ending debt of gratitude to this outstanding supporter of aviation.

The story of Thomas C. Allen, one of the first black pilots in Oklahoma, could be a best-selling novel entitled "Oklahoma's Hobo Pilot."

Allen was born in 1907 in a small farming community about 95 miles east of Dallas, Texas. His parents were both teachers in an all-black school.

When he was only three months old, his father died leaving his mother with three young children to raise, a farm, and a total monthly salary of only $35.00. Needless to say, the next few years for the Allen family would not be easy.

In 1918, barnstorming was in its infancy. A dare-devil pilot from Dallas landed in a cow pasture in the area where Tom Allen was living, and, as luck would have it, the propeller of the plane was damaged. The plane was grounded until replacement parts arrived from Dallas. Thomas and several of his friends thus had the opportunity to thoroughly examine this strange machine. As he talked with the pilot, Allen told him "Someday I'm going to fly one of these." Thus began a lifetime of aviation history.

The next year, when Thomas was 12 years old, his mother moved with her family to Oklahoma City to continue her career as a teacher in a small country school.

At that time there were only two landing fields in Oklahoma City--both were cow pastures. One was located a quarter of a mile east of the recently completed State Capitol, the other one was far out in the country, about two miles north of the Capitol.

Tom quickly discovered these landing fields where they had a few broken-down planes, but they were enough to capture his imagination. Tom made many trips on his bicycle to the north landing field which was operated by Robert Tarbutton. He soon became friends with the pilots and mechanics, and they allowed him the privilege of wiping the grease from the planes and other such jobs.

His first ride in one of the planes, costing a hard-earned $2.50, was a 20-minute flight around the north side of Oklahoma City. This ride convinced him more than ever that he wanted to be a pilot.

From that time on, every spare moment was spent with the planes and those responsible for their maintenance. He offered his saxophone as a down-payment for a flying course, and Mr. Tarbutton agreed to let him work out the remainder of the $300 tuition.

After five months of working on airplanes, Tom had earned an hour of flying time in the air.

Pilot training at that time consisted of allowing the student to ride with the pilot, holding and helping him to direct the control stick and rudder bar. No instruments were involved, as the only indicator on the panel was the oil gauge. All landings and altitude measurements were strictly visual estimates. The entire course consisted of five hours flying time. The hopeful students who were unable to successfully

do loops, rolls, and other maneuvers after five hours of training were considered to be wash-outs.

Tom had completed his five hours in the air, but had not soloed. Even though most of the planes were only worth about $300, it required a $500 bond to fly alone and Tom didn't have this much money.

His first solo flight was a result of a dare. Mr. Tarbutton, the owner of the planes, had gone to Oklahoma City on business. The mechanics, meanwhile, were teasing young Tom, then 16 years old, about not having taken his solo flight. He, in turn, told them that if they would gas up the plane, he would fly it. They did, and he did. As he landed and taxied toward the group, he was met by Mr. Tarbutton who had arrived at the field just in time to see Tom begin his flight. The irate owner soon realized that his plane was undamaged, forgave Tom, and continued to help him in his aerospace education.

It was time to move on. With $9.88 in his pocket, Allen hitchhiked to San Antonio, Texas. He worked for several years in the salvage yards at both Stinson and Kelly Fields as a general handyman and mechanic's helper. He then returned to Oklahoma City in 1928 where he worked for Tom Braniff who was just starting his new airline company.

In 1929 there were only eight black pilots in the entire country. Headquarters for this group was in Los Angeles, California, where they had established a black Aero Club. Allen learned of their activities and headed for California, only to find that the Aero Club did not even own a plane. He worked at various airports for a while as mechanic, then in 1932, he learned that there was a $1,000 prize offered to the

first black pilot to complete a cross-country flight. Tom Allen, now 25 years old, was determined to win this prize.

J. Herman Banning, another black pilot from El Reno, was also interested in making this flight. Banning had an old Eaglerock plane which was in dire need of repair. Allen and Banning pooled their resources, and on September 19, 1932, with only $25.00 in their pockets, they left the Los Angeles airport on the first leg of this historic flight.

Fortunately, both Allen and Banning had many friends along the route, and at each stop funds were solicited to buy sufficient gas to get them to their next destination. Aviation gasoline at that time cost 29½¢ per gallon. Lodging, food, and necessary repairs to the plane were also furnished by friends, both old and new. Thus Allen and Banning became known as the "hobo pilots."

When they finally arrived in New York City 14 days later, they were unable to locate the person who had offered the $1,000 prize, therefore their return to Los Angeles was also unfinanced.

Banning was killed a short time later while doing some exhibition flying.

Allen worked for many years in Los Angeles for Douglas Aircraft Company. He retired in the 1950s and moved back to Oklahoma City.

Since the Oklahoma Aviation and Space Hall of Fame and Museum opened in April, 1980, Tom Allen has worked in the museum as a tour guide and has kept busy giving lectures about his remarkable flight in 1932 with J. Herman Banning.

Following WW II, many of the young pilots returned to Oklahoma and proceeded to develop aviation as a major industry. Many of the airfields which had been training sites during the war were converted to civilian use and we began to tie aviation to the industrial development of our State.

Even though Oklahoma has progressed from the barnstormers to a state that boasts a strong air space industrial base, we have not lost the color and excitement of aviation. We have fly-ins, soaring, modeling, parachuting, hot-air balloons, some of the better air shows, and fun flying to our many fine resorts. Flying Farmers are active as well as many other flying groups.

Like any organization, the International Flying Farmers had a beginning. The year was 1944. The scene was the campus of Oklahoma A. and M. College (now Oklahoma State University) at Stillwater. The late Dr. Henry G. Bennett, President of the University, and several associates recognized the growing interest in airplanes among farmers. August of that year saw the birth of the Oklahoma Flying Farmers Association. There were 38 charter members.

The flying farmer idea spread with the fury of the prairie fire. Other states began clamoring for information. They wanted to know how they could join the airborne farmers.

Fortunately, the farsighted Oklahomans laid the groundwork for a national organization. In January of 1946, the National Flying Farmers' Association was incorporated as a non-profit organization under Oklahoma law.

Original headquarters was in Stillwater, Oklahoma, where the first national convention was held in August of 1946. Sixteen states were represented. Interested farmer-flyers arrived in 262 planes and enthusiasm was at a high pitch.

In 1952 the national headquarters was moved to its present location in Wichita, Kansas.

Today, it has more than 10,000 members in the United States, Canada, and Mexico, with isolated members scattered throughout many other parts of the world. For this reason, at the 16th annual convention held in Tucson, Arizona, in 1961, the name was changed from National to International.

Flying farmers own over 5,000 airplanes and approximately 4,000 landing strips. These airplanes are a part of their farm equipment. To dust crops, to haul supplies into areas not accessible by road, to feed livestock marooned by blizzards, and to check fences are only a few of the utilitarian uses.

Flying is fun. In many cases, every member of a Flying Farmer family has earned a pilot's license.

The Ninety-Nines, Inc. derives its name from the number of charter members who organized to further the role of women in aviation. On November 2, 1929, twenty-six of this group met at Curtiss Field, Long Island, N.Y., and launched The Ninety-Nine Club officially. Amelia Earhart became the first president.

The purpose of this organization is to engage in educational, charitable and scientific activities, and to provide a close relationship among women pilots and to unite them in any movement that may be

for their benefit or for that of aviation in general.

Membership in the Ninety-Nines is limited to women possessing active pilot licenses.

Ninety-Nines assist with, and many also belong to, national youth education and aerospace education groups such as the Civil Air Patrol, Civil Defense, National Aerospace Education Council, the Wing Scouts (Senior Girl Scout and Guide Aviation Program), Annual Proficiency Test, Accident Prevention Program, and National Intercollegiate Flying Association, by giving indoctrination flights, acting as consultants, teaching ground school subjects, and lecturing on personal aviation experiences. They also sponsor the Powder Puff Derby cross-country race.

Local headquarters for this active group is located at Will Rogers World Airport, Oklahoma City.

The Civil Air Patrol was founded on December 1, 1941, as part of the Office of Civil Defense for the purpose of providing a volunteer civilian air fleet in time of national emergency. During World War II, CAP was transferred to the U.S. Army Air Corps and its civilian pilots flew coastal patrol anti-submarine missions as well as border patrol, target towing, courier and other miscellaneous missions.

In 1946 CAP became a federally chartered, private, non-profit corporation, and in 1948 was chartered as the official civilian auxiliary of the United States Air Force.

The CAP cadet program is designed to provide leadership and moral training as well as aerospace education and physical fitness to young men and women aged 13 to 21. The program stresses involvement by the

cadets in many aviation and community service activities. CAP cadets spend their summers at encampments on USAF facilities and in many special activities. Travel and scholarship opportunities are also available to qualified CAP cadets.

Aerospace education is a major mission of CAP and is divided into the following two areas:

1. Internal: Providing an aerospace education to its own membership, both adult and cadet. CAP strives to develop aerospace leaders who serve as local community resources in aerospace.

2. External: CAP provides a diversified aerospace education program to the citizenry, again for the purpose of developing an understanding and appreciation of the importance of aerospace in our society.

Several organizations were formed for the purpose of safeguarding the health and safety of our citizens. For example, the M.A.S.T. (Military Assistance to Safety and Traffic) group at Ft. Sill had its beginning in 1973. The personnel of the 4-507 Medical Company (A.A.) maintain constant 24-hour readiness to furnish assistance wherever they are needed. The Life Flight at Saint Francis Hospital in Tulsa was organized in 1979, and the Medical Flight at Oklahoma Children's Memorial Hospital in Oklahoma City which began in 1980, both provide emergency air lift throughout the state. Helicopters as well as small aircraft have been modified for these service organizations.

Astronauts from Oklahoma have made significant contributions to the exploration of outer space. We are justifiably proud of Thomas P. Stafford of Weatherford, Gordon Cooper of Shawnee, Owen K. Garriott of Enid,

William R. Pogue of Sand Springs, Stuart A. Roosa of Claremore, and Dr. Sharon W. Lucid of Bethany.

Oklahoma has also become a leader in yet another phase of aviation. Aerospace Education Workshops have provided over 800 teachers with an understanding and appreciation for the aerospace world. These teachers represent all areas of instruction and all grade levels, K-12. In cooperation with these workshops, a special workshop, entitled "Operation High Flight," is held for high ability students interested in aerospace or aviation education.

Dr. Kenneth Wiggins of Oklahoma State University has been the motivating force responsible for the success of the Aerospace Education Workshops in Oklahoma. He is an outstanding leader on the national level as well as respected by teachers and administrators in the public schools of Oklahoma. Dr. Wiggins and his staff have continually provided the untiring enthusiasm necessary for a project of this scope.

In June of 1968, Governor Dewey Bartlett appointed a committee on air education to bring about a greater awareness in the public schools of the impact of the aerospace industry in Oklahoma. This committee recommended to the Oklahoma Aeronautics Commission the major components of the workshops that were implemented in the summer of 1969.

The Aeronautics Commission, which is responsible for the funding of these workshops, had six goals when the project began. These goals were as follows:

1. To stimulate a widespread awareness of aerospace education at all levels of instruction

2. To develop a means to stimulate the teacher's interest in aerospace education

3. To train teachers and administrators in the application of aerospace education in the schools

4. To make aerospace education available to all grade levels of Oklahoma students

5. To encourage closer affiliation between educational institutions and the aviation and aerospace industries

6. To train teachers for a specialized course in aviation at the high school level

An evaluation of the success of these workshops indicates these goals have been met with 100% effectiveness.

As a result of the Aerospace Education Workshops, a group of Oklahoma teachers formed the original chapter of the National Aerospace Education Association. The NAEA aids education at all levels to include aerospace concepts in their curriculum; acts to develop leaders and bring aerospace education leadership skills and activities to schools and communities throughout America; makes available current information on career opportunities in the field of aerospace, the two major segments of which are aviation and space.

Margaret Wiggins, principal at Skyline Elementary School in Stillwater, was recently selected by the Oklahoma chapter of the NAEA as the outstanding aerospace teacher in the state.

According to Mrs. Wiggins, "Aerospace education is a subject that crosses all academic discipline. It can be adapted to all levels of learners. The true rewards come when student enthusiasm is observable, when there is a marked increase in study habits and skills, and when the subject matter becomes alive and relevant. When former students ask if we are still studying aerospace at Skyline, then you know it is effective."

President Ford pointed out that "Despite all the other Twentieth Century achievements of technology, radio, the automobile and television, our era will probably be known best as the Age of Flight."

The progress of aerospace in Oklahoma has spanned the years with a rapidity unequaled in any other technological field.

How do you prepare students for a future which includes the exploration of outer space? Aerospace education is both exciting and effective. It may also be the key to our future success of aerospace in Oklahoma.

HISTORY OF FLIGHT

Since the earliest times, people have watched the birds in the sky and dreamed of flying.

One of the oldest stories of flying is the Greek legend of Daedalus and his son, Icarus. To escape from the island of Crete, they fastened wings of feathers and beeswax to themselves. Daedalus flew safely to Naples, but Icarus flew too near the sun. The wax on his wings melted and he fell into the sea.

Around 1500 Leonardo DaVinci designed a flying machine called an ornithopter. It had flapping wings which were worked by a man's arms and legs. Though his flying machine didn't work, DaVinci was the first real scientist in the history of flight.

The first successful flying machine was a balloon built by the Montgolfier brothers in 1782. A duck, a sheep, and a rooster were the first passengers. In November of 1783, two men floated over Paris for 25 minutes in another Montgolfier balloon.

Now men were in the air, but they could only drift with the wind. There was little they could do to control the balloons.

The dirigible, also called an airship, was a balloon that had an engine and could be steered with a rudder. The first successful dirigible was flown in 1852. It was shaped like a cigar and had a steam engine that turned a propeller. The LaFrance airship, built in 1884, was the first airship which could be steered in any direction regardless of wind. It was powered by an electric motor.

In 1900 the first zeppelin was built. A zeppelin was a large rigid dirigible with a cigar shaped framework of aluminum. It was named for the man who designed it, Count Ferdinand von Zeppelin of Germany. Zeppelins were used during World War I to drop bombs on London. After the war they were used to carry passengers across the Atlantic Ocean and to other parts of the world. The Hindenburg, the largest zeppelin, made 35 trips across the Atlantic Ocean. On May 6, 1937, it exploded and burned while trying to land in New Jersey. Thirty-six of the passengers were killed. After this incident no more zeppelins were built.

While the airships were being developed, other aircraft were being built with wings.

In Germany, Otto Lilienthal was building gliders with curved wing tops and control surfaces. In 1890 he began flights that proved it was possible to use the lift of the air to fly machines that were heavier than air. He made more than 2,000 flights. His notes and drawings were studied by students of flight everywhere.

Even as boys, the Wright brothers had been interested in flying. They often watched the buzzards flying and noticed how they twisted the back edge of one wing downward and the back edge of the other upward. They built a kite that had two wings with cords attached at the tips so the wings could be twisted, or warped.

After their success with the kite, the Wright brothers experimented with gliders. In 1902, at Kitty Hawk, North Carolina, they made many successful flights in their third glider. This glider had two wings like the kite, but it also had an elevator and a rudder for control. Now they were ready to build a machine that could fly under its own power.

In December of 1903 the brothers returned to Kitty Hawk with their new machine, the Flyer. It had a motor and propellers of their own design. On December 17, 1903, flights were made by Orville and Wilbur Wright. The first flight lasted for only 12 seconds and went 120 feet.

In 1909, Louis Bleriot flew his monoplane across the English Channel from France to England. This was the first time anyone had flown across a body of water. It was also the first time an airplane had been flown from one country to another.

Also in 1909, Madame La Barrone de Laroche became the first woman pilot. In that same year the first Army airplane was built.

Glenn Curtiss, the father of naval aviation, flew his first successful seaplane in 1911. During that same year one of his other planes landed on the deck of a ship for the first time.

The need for better planes during World War I caused the airplane to be greatly improved during that time. Not only could they fly faster but they were much safer.

In May of 1918, the United States began airmail service between Washington, D.C. and New York City. After the war ended in November of 1918, many old war planes were made into mail planes. Soon mail service expanded all over the country.

In 1919 a prize of $25,000 was offered for the first nonstop flight from New York to Paris. Charles Lindbergh won that prize. He left New York on May 20, 1927, in the "Spirit of St. Louis." He landed in Paris 33 hours and 30 minutes later. Lindbergh became an aviation hero overnight.

Amelia Earhart was another famous pilot. In 1932 she became the first woman to fly across the Atlantic Ocean alone. Her flight from Newfoundland to Ireland took about 14 hours. In 1937, she and her navigator set out on a flight around the world. They were last heard from when they were over the Pacific Ocean. All searches failed to find any trace of her or her aircraft.

While most designers were working to improve the airplane, a few were working on the helicopter. In 1907 a helicopter was flown about 5 feet in the air, but it was almost impossible to control. In 1939 Igor Sikorsky perfected the single-main-rotor helicopter.

The next 40 years saw many improvements in aviation. Airplanes grew from the single engine propeller planes, such as those flown by Lindbergh and Earhart, to present day jumbo jets, such as the 747.

Man is still dreaming about flying higher and faster. Research is being done to develop aircraft that can fly faster and also be quieter and more fuel efficient.

TITLE:	ABCs of Aerospace
CONCEPT:	Young children can learn aerospace words by constructing a picture dictionary.
PURPOSE:	To construct a picture dictionary of aerospace terms

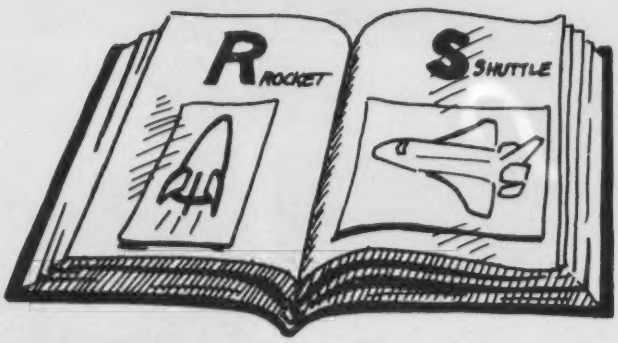
MATERIALS:

booklet made from folded writing paper stapled to construction paper cover
scissors
paste
magazines
crayons

PROCEDURE:

1. The student will have a page for each letter of the alphabet on which to record words related to aerospace.

2. Illustrate by drawing or pasting pictures cut from magazines.

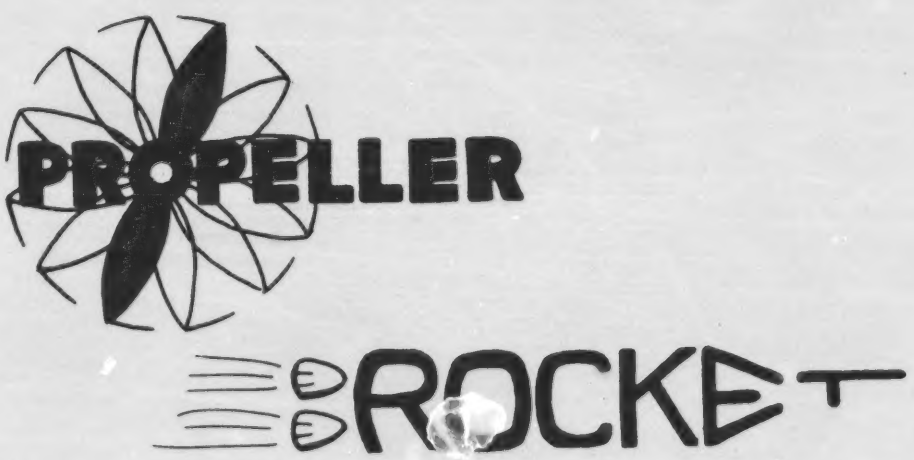


TITLE:	Finish the Picture
CONCEPT:	The picture will be completed when directions are followed.
PURPOSE:	To reinforce reading vocabulary words related to space and aviation

MATERIALS: activity sheets, one for each student
assorted crayons

PROCEDURE:

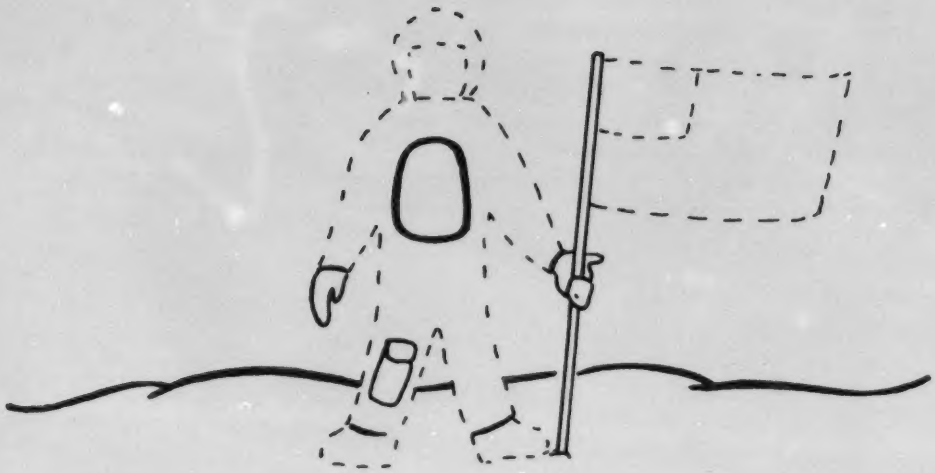
1. Distribute activity sheets.
2. Have students follow instructions printed on activity sheet
3. Post completed pictures on bulletin board for all to see and appreciate.



AVIATION ART

1. Draw a man in the airplane.
2. Draw a propeller on the airplane.
3. Draw a wheel on the airplane.
4. Color the airplane red.
5. Draw a rocket in the upper left corner.
6. Color the rocket blue.
7. Draw a kite in the lower right corner.
8. Color the kite green.
9. Draw the sun in the upper right corner.
10. Color the sun orange-yellow.
11. Draw a balloon in the lower left corner.
12. Color the balloon purple.

SPACE ART



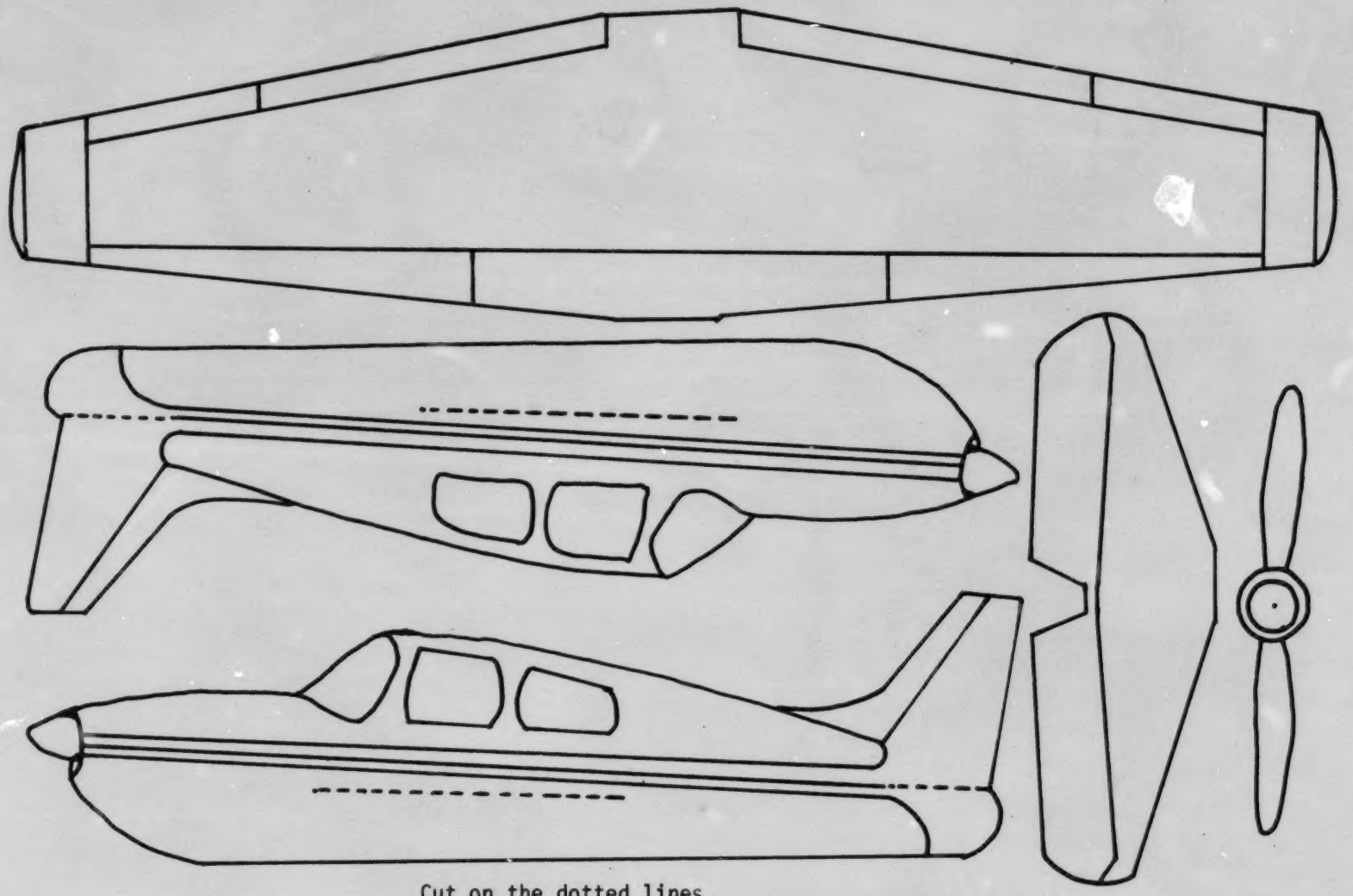
1. Make the lines solid.
2. Color the space suit silver.
3. Color his face plate gold.
4. Put stars and stripes on the flag.
5. Color the stars white.
6. Color the star field blue.
7. Color some of the stripes red.
8. Color some of the stripes white.
9. Color the flag pole brown.
10. Draw the man's spacecraft he landed in.

TITLE:	Paper Airplanes
CONCEPT:	Paper airplanes can be made with a minimum of time and equipment.
PURPOSE:	To make an airplane

MATERIALS:
paper pattern
cardboard
scissors

PROCEDURE:

1. Paste the pattern on cardboard
2. Cut out
3. Assemble
4. Color as desired



Cut on the dotted lines.

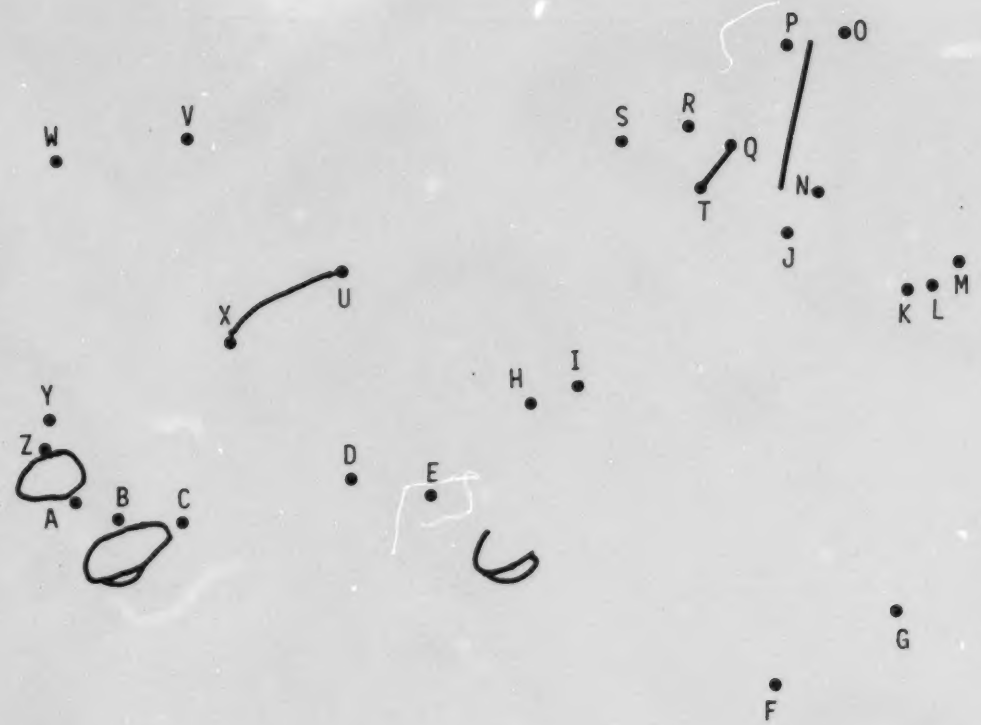
TITLE:	Aircraft Dot-to-Dot
CONCEPT:	Sequence of the alphabet can be practiced by following the dots.
PURPOSE:	The students will make a picture of an aircraft by connecting the dots in the correct sequence.

MATERIALS:
worksheet
pencil or crayon

PROCEDURE:

1. Distribute worksheet to each student.
2. Connect the dots in order from A to Z to form the picture of the aircraft.

AIRCRAFT DOT-TO-DOT ACTIVITY SHEET



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TITLE:	What Will I Need?
CONCEPT:	Cutting and pasting can be used to stretch one's imagination about what one would need on another planet.
PURPOSE:	The students will be able to make a composite picture (montage) of objects that he/she would need to survive on another planet.

MATERIALS:
old magazines
scissors
paste
construction paper

PROCEDURE:

1. Have the students talk about what they would need if they lived on another planet in space.

2. Give them old magazines and let them cut out the various pictures.

3. When they have what they think they will need, show them how to paste them on a piece of construction paper, overlapping in the montage manner. The paper can be cut in circular shape after they have finished their pasting.

   NOTE: This same activity can be done with different themes.

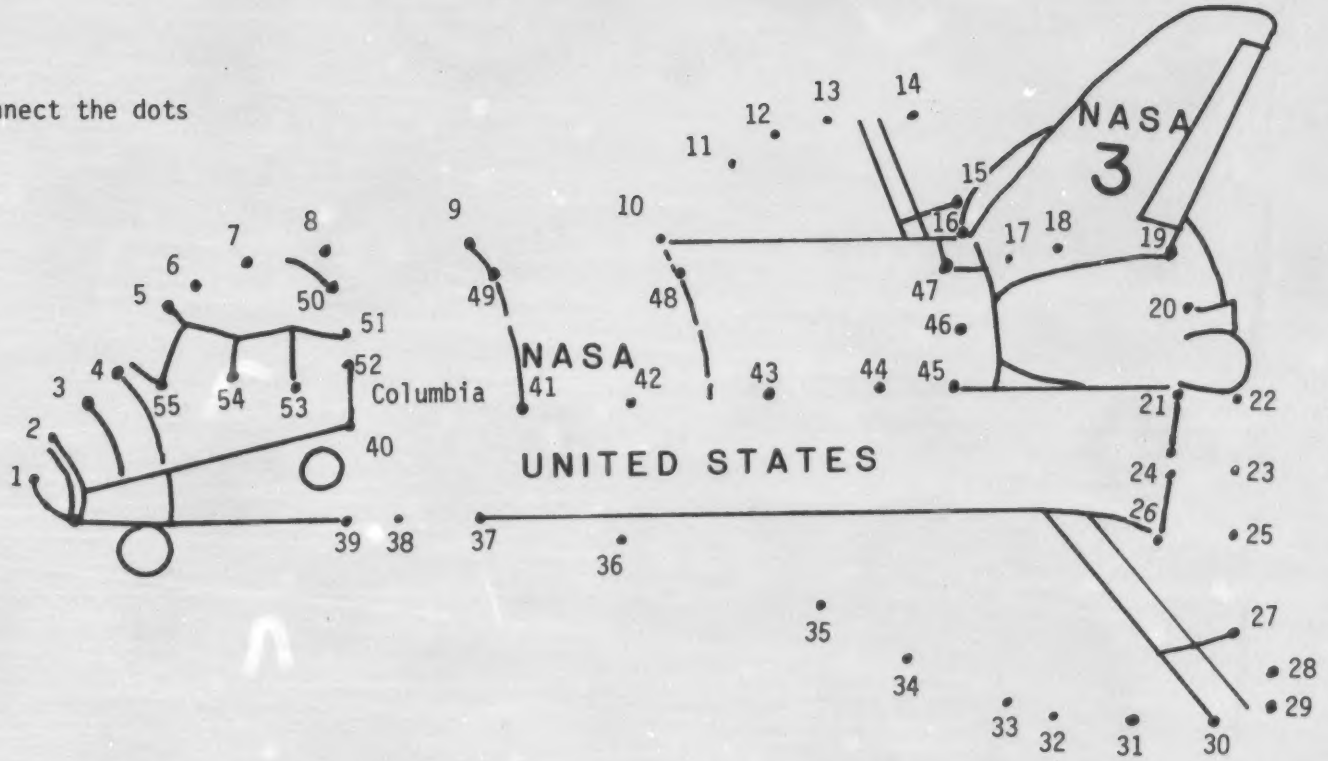
TITLE:	Space Shuttle Dot-To-Dot
CONCEPT:	Numerical sequence can be practiced by following the dots.
PURPOSE:	To create a picture of the latest space shuttle and to improve counting ability.

MATERIALS:
activity sheet
pencil
crayons

PROCEDURE:

1. Distribute worksheet to each student.
2. Connect the dots in order from 1 to 55.
3. Color as desired

Connect the dots



TITLE:	Where Am I?
CONCEPT:	Students can learn spatial relationships by using familiar words and symbols.
PURPOSE:	To teach spatial relationships, develop vocabulary, and learn to follow directions

MATERIALS: flannel board
flannel shapes of: airplane, clouds, bird, wind, star, grass, tree, etc.

PROCEDURE: The teacher will give the following directions:

1. Place the airplane in the middle of the flannel board.
2. Place the two clouds above the airplane.
3. Place the bird between the clouds.
4. Place the wind behind the airplane.
5. Place the star in front of the clouds.
6. Place the grass under the airplane.
7. Place the ground near the bottom of the flannel board.
8. Place the tree on the ground.

TITLE:	Aerospace ABCs
CONCEPT:	Alphabetizing is the arranging of words in the order of the alphabet.
PURPOSE:	The students will practice the skill of alphabetizing by the first letter using aerospace words.

MATERIALS: worksheets
pencils

PROCEDURE:
1. Distribute copy of worksheet to each student.
2. Alphabetize as directed on worksheet.

ABC ORDER

Number each set in abc order.

_____	Earhart	_____	balloon
_____	Lindbergh	_____	glider
_____	Wright	_____	zeppelin
_____	Curtiss	_____	airplane
_____	Lilienthal	_____	dirigible
_____	Montgolfier	_____	jet
_____	Icarus	_____	ornithopter
_____	Zeppelin	_____	monoplane
_____	Sikorsky	_____	biplane
_____	Yeager	_____	helicopter

Make a sentence by putting the words in abc order.

1. can float balloon A miles many

_____

_____

2. no has glider A power

_____

_____

3. hovers one helicopter A in spot

_____

_____

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TITLE:	Scrambled Sentences
CONCEPT:	For a sentence to have meaning, words must be in proper sequence.
PURPOSE:	The students will arrange the words in proper sequence to form sentences about the history of flight.

MATERIALS: worksheets
pencils

PROCEDURE:

1. Distribute copy of worksheet to each student.
2. Follow instructions given on worksheet.

NOTE: This sheet could be part of an interest center along with books and pictures concerning the history of flight.

PUT THE WORDS IN ORDER TO MAKE SENTENCES ABOUT THE HISTORY OF FLIGHT.

1. machines Balloons were the first flying

_____

_____

2. largest The built Hindenburg was the zeppelin

_____

_____

3. the aircraft Gliders with wings were first

_____

_____

4. successful Kitty Hawk made Wright brothers The first the flight at power-driven

_____

_____

5. across solo made Lindbergh the first flight non-stop Ocean the Atlantic

_____

_____

6. to fly across solo the first Amelia Earhart woman was the Atlantic

_____

_____

TITLE:	Jump Rope Chant
CONCEPT:	Rhythm and timing for jumping rope can be developed with an aerospace chant.
PURPOSE:	To improve gross motor coordination while reciting aerospace chants

MATERIALS: jump rope

PROCEDURE:

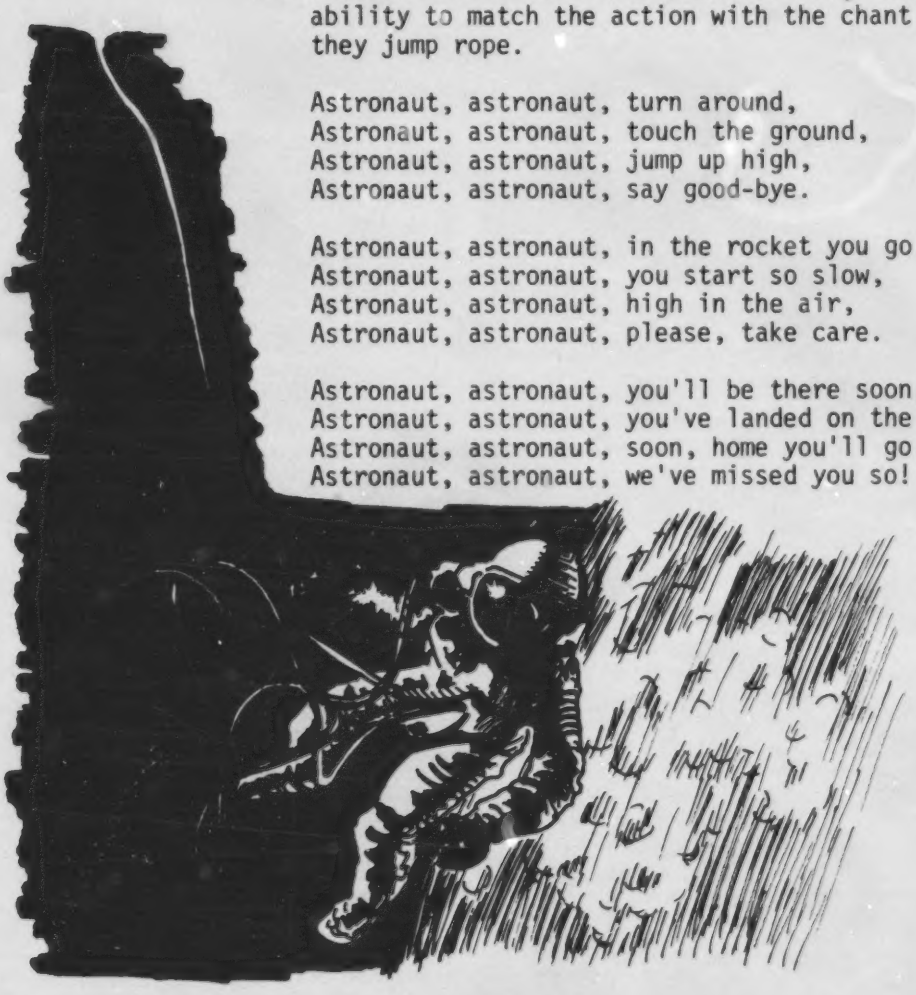
1. Teach Aerospace Chant.

2. Students will take turns demonstrating their ability to match the action with the chant as they jump rope.

Astronaut, astronaut, turn around,
Astronaut, astronaut, touch the ground,
Astronaut, astronaut, jump up high,
Astronaut, astronaut, say good-bye.

Astronaut, astronaut, in the rocket you go,
Astronaut, astronaut, you start so slow,
Astronaut, astronaut, high in the air,
Astronaut, astronaut, please, take care.

Astronaut, astronaut, you'll be there soon,
Astronaut, astronaut, you've landed on the moon,
Astronaut, astronaut, soon, home you'll go,
Astronaut, astronaut, we've missed you so!



TITLE:	Solar System Play
CONCEPT:	There are nine planets rotating around the sun. This is called the Solar System.
PURPOSE:	To teach the names, positions, and characteristics of the planets and the sun

MATERIALS: Simple costumes to represent the different planets (can be hats made of construction paper)

PROCEDURE: Students portray the different planets of the solar system and the sun.

Sun
I am the sun, your daytime star.
I am the ruler of the solar system.
The planets are members of my family.
I keep them in their paths and control their speeds.
I shine by my own light, but the planets catch my light and reflect it.
Here is my family now.
Would you like to meet them?

Mercury
I am Mercury, the swiftest of the sun's family.
I go around the sun in 88 days.
I keep one side to the sun so on one side it is always day and on the other side it is always night.
You sometimes call me the morning and evening star.

Venus
I am Venus, the second planet from the sun.
My path is between the earth and sun, so I am very hot.
Clouds around me reflect the sun's light, making me seem very bright.
You also call me the morning and evening star.

Earth
I am the Earth, the planet on which you live.
I travel on the sun's third road and turn myself around every 24 hours to make day and night.
I go around the sun every 365 days, which makes one year.
One moon goes around me as I go around the sun.

Mars

I am Mars, colder than the earth because I'm further from the sun.
I look red and my color is thought to come from minerals in my rocks and soil.
I, too, have day and night, but my year is nearly twice as long as yours because it takes me longer to go around the sun.
Maybe you can visit me some day.

Jupiter

I am Jupiter, the icy giant of the sky.
I travel in the sun's 5th orbit, but my road is so long it takes nearly 12 years to go around the sun.
I am the largest of the planets and I have 12 moons around me.

Saturn

They call me Saturn, the planet with beautiful rings around me.
I am very large and bright, and my colored rings may be formed by ice reflecting light somewhat like raindrops forming a rainbow.
I am cold because I am far from the sun.
I travel on the 6th road around the sun and it takes 29 1/2 years to go around.

Uranus

I, Uranus, the 7th planet from the sun, am a green giant four times larger than the earth.
Very little is known about me yet, but my journey around the sun takes about 84 years.

Neptune

I am Neptune, and I look enough like Uranus to be his green twin, only smaller because I'm further away from you.
My road is the 8th circle around the sun, and so very long that it takes about 165 years to go around.
Men on your earth are working very hard to find out more about me.

Pluto

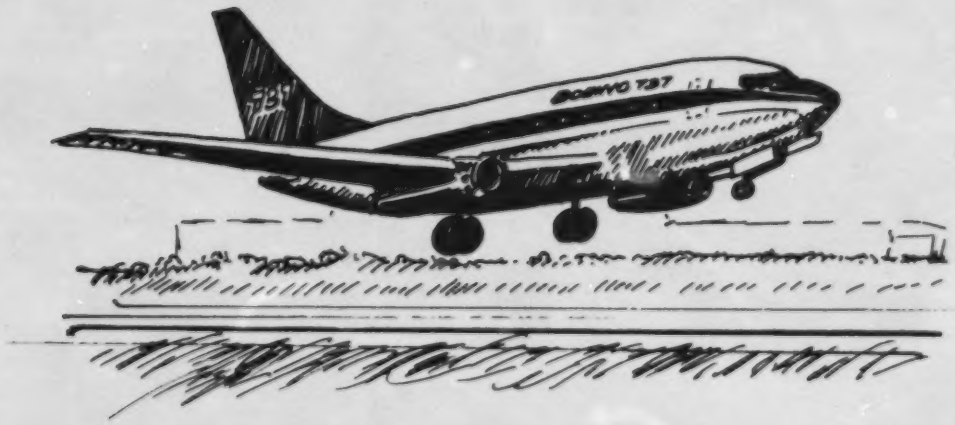
I am Pluto, called the mysterious planet because I was discovered only about 40 years ago.
I am very small and dark and travel in the 9th path around the sun.
I am about 3 1/2 billion miles from the sun and I take 248 years to circle once.
I am the last known planet.

TITLE:	Aerospace Word Wall
CONCEPT:	Pictures of the solar system, aircraft, and aerospace-related topics will aid students in learning vocabulary words.
PURPOSE:	To build a working vocabulary of aerospace terms

MATERIALS:
wall-sized poster of solar system, spacecraft, astronauts, etc.
cards
markers

PROCEDURE:

1. Mount large pictures on the wall or bulletin board as new vocabulary words are introduced.
2. Let children take turns writing words on cards and placing them on the wall.
3. Children can practice reading words aloud, use them in creative writing, put them in notebooks, etc.



TITLE:	The Hot-Air Balloon Festival
CONCEPT:	Hot-air balloons can provide a good outlet for creative talent.
PURPOSE:	Students will create and decorate their own hot-air balloon model

MATERIALS:

round balloons (one per student)
old newspapers
glue
water
containers for glue mixture
string or yarn
paper cups
strawberry baskets or small boxes
paint
markers
crayons

PROCEDURE:

1. Students will inflate a balloon and cover it with strips of newspaper dipped in a mixture of equal parts of glue and water (paper mache' technique is the proper term for this).

2. When balloons are thoroughly dry, use a pin to prick the balloon.

3. Attach strings around the balloon (or be creative and figure out a way to weave a net to completely surround the balloon).

4. Hang a cup, small basket, or small box on the bottom to simulate the gondola.

5. Students then paint the balloons using a design of their own choosing. Encourage creativity.

6. Hang the balloons from the ceiling using thin string, or display them elsewhere in the building.

Follow-up Activity: Use the balloons as a springboard to creative writing projects.

Alternate Activity: Use elongated balloons and create dirigibles or blimps.

TITLE:	Ten Little Spacemen
CONCEPT:	Laterality skills and ordinal number concepts can be developed through music.
PURPOSE:	To use music and movement with a "space" theme to teach and reinforce concepts

MATERIALS: piano and music "Ten Little Indians" or record player and record "Ten Little Indians"

PROCEDURE:

1. Arrange students in row(s) or in a circle.
2. Let students take turns as leader of action indicated in each verse of song. (Repeat as necessary so all students will get a chance to be leading spaceman.)

TEN LITTLE SPACEMEN

1 little, 2 little, 3 little spacemen,
4 little, 5 little, 6 little spacemen,
7 little, 8 little, 9 little spacemen,
10 spacemen in a row.

The 1st little spaceman shakes his right hand
The 1st little spaceman shakes his right hand
All the little spacemen shake their right hands
Standing in a row.

Follow the pattern above.

The 2nd little spaceman shakes his right foot

The 3rd little spaceman shakes his left hand

The 4th little spaceman shakes his left foot

The 5th little spaceman touches his shoulder

The 6th little spaceman touches his nose

The 7th little spaceman touches his elbow

The 8th little spaceman taps his right heel

The 9th little spaceman taps his left heel

The 10th little spaceman shakes it all around

Bridge between verses:

Clap and clap and stamp, stamp, stamp
Clap and clap and stamp, stamp, stamp
Clap and clap and stamp, stamp, stamp
Standing in a row.

Alternate bridge between verses:

Gallop round and round the circle
Gallop round and round the circle
Gallop round and round the circle
Get back in a row.

Children are singing the bridge as spaceman no. 1 leads the activity.

NOTE: Alternate the bridges between verses.

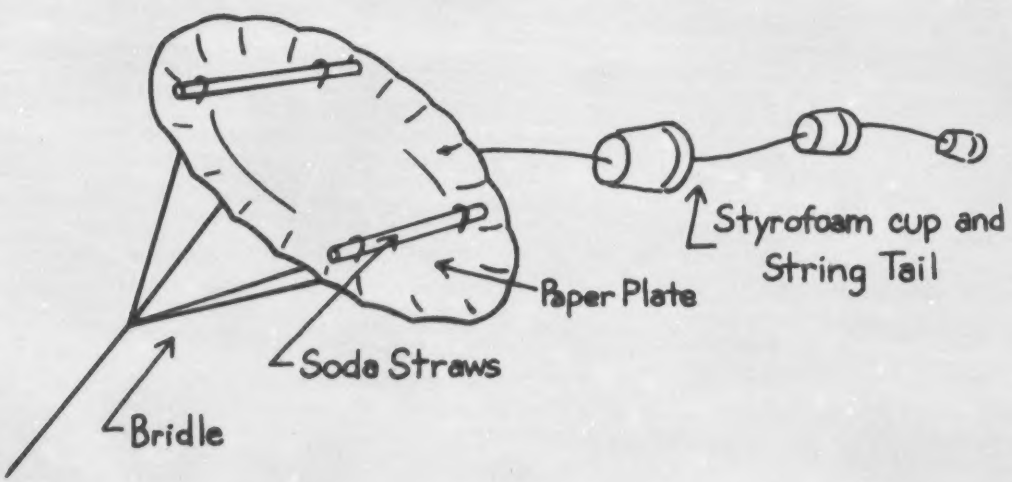
TITLE:	Picnic Flier
CONCEPT:	Kites have many shapes and forms.
PURPOSE:	The students will construct kites from easily obtained materials.

MATERIALS:

paper plates
two soda straws
three styrofoam cups
kite twine

PROCEDURE:

1. A good example of aerial improvisation is the picnic flyer, which is simply a properly bridled, ordinary paper plate, stiffened with soda straws and fitted with a light-weight tail consisting of styrofoam drinking cups strung on a length of string.
2. Construct kites according to illustration.
3. Have a kite-flying contest in a large, open area.
4. Give prizes for kite going highest, farthest, etc.



TITLE:	Living in Space
CONCEPT:	Living in space has some unique characteristics different from living on earth.
PURPOSE:	To demonstrate characteristics of living in space through a series of activities.

MATERIALS:

four or five large shirts
three or four pair of trousers
two or three belts
thermos bottle
jar
hot water
portable hair dryer
squirt gun
milk
instant pudding mix
plastic bags
art supplies

PROCEDURE: Various activities are given. Use the ones appropriate for your particular class.

1. Dress a child in multiple layers of shirts, pants, and belts, to simulate the restrictions of space-suits. Have the child perform the following activities (but don't prolong them): bend down and touch his toes, attempt to catch a ball, lie down to prepare for sleep, climb on a chair, walk up or down stairs.

2. Have the children draw pictures of an astronaut in his spacecraft.

3. Construct a rocket or space station from cartons or cardboard. Make astronaut helmets from paper sacks, cartons, or large plastic bottles.

4. To demonstrate how a spacecraft protects astronauts against temperature extremes, put hot water in a jar and in a thermos. After a short time, check the temperature of each.

5. Place nozzle of a portable hair dryer inside a child's clothing to show circulation possible with individual portable air conditioning for spacesuits.

6. To demonstrate how astronauts eat and drink, drink water from a squirt gun. Make instant pudding in a plastic bag, squeezing to mix. Eat pudding from a corner of the bag.

7. Dramatize a trip into space.

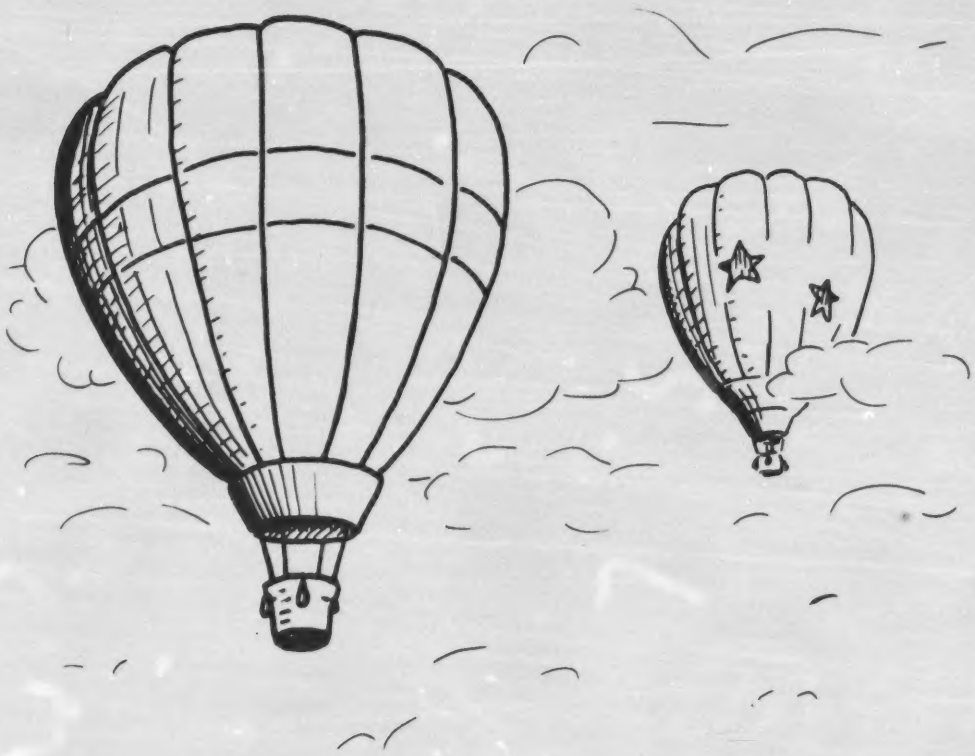
8. Create a game that an astronaut might like to play in space. Keep the lack of gravity and crowded conditions of the space station or shuttle in mind.

TITLE:	Aerospace Word Search
CONCEPT:	Aerospace terms can become a part of the students' expressive and receptive vocabulary.
PURPOSE:	Learning aerospace vocabulary can be reinforced by use of word search fun sheets.

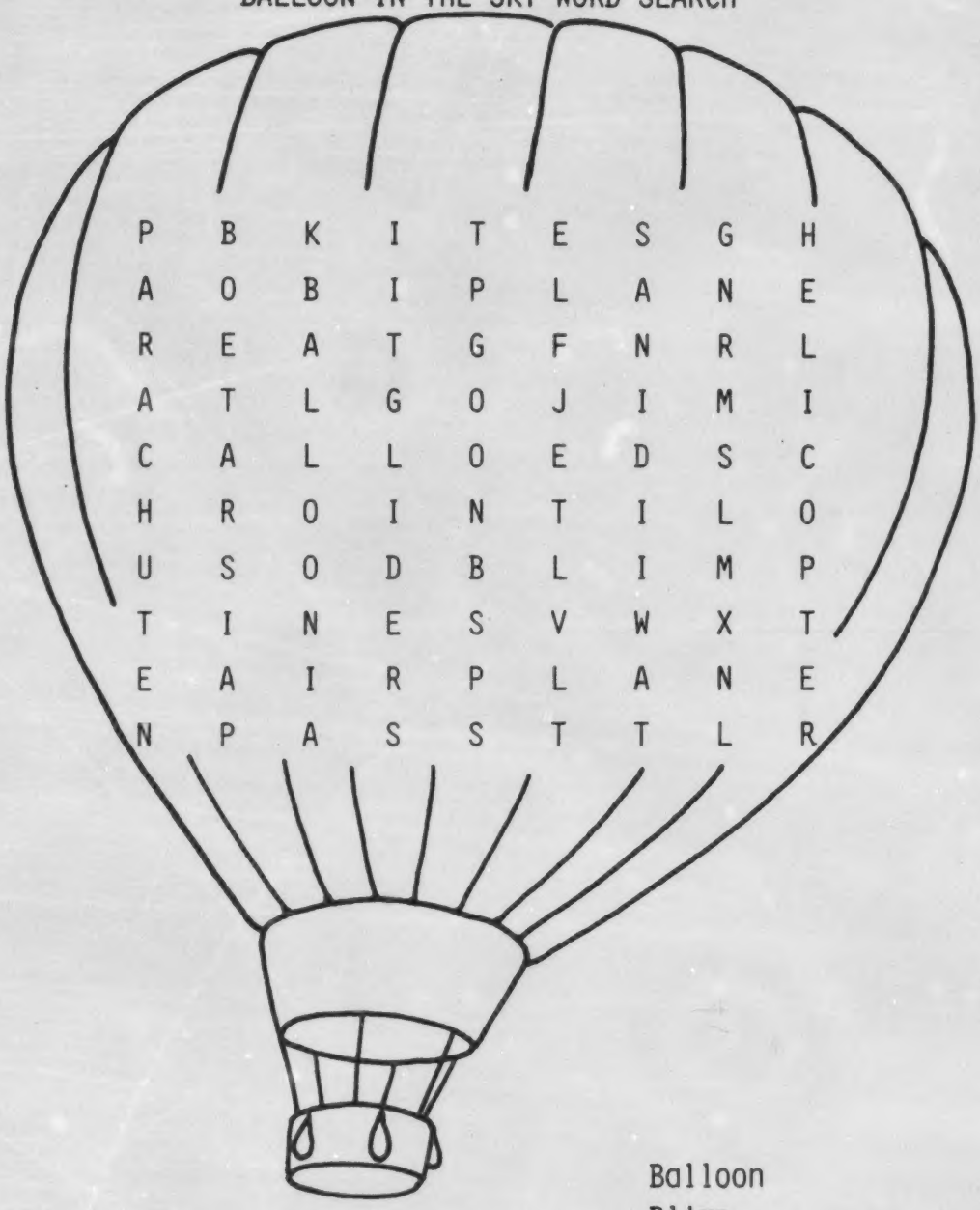
MATERIALS: word search activity sheet
pencil

PROCEDURE:

1. Distribute copy of word search activity sheet to each student.
2. Instructions for completion of the activity are on the word search sheet.



BALLOON IN THE SKY WORD SEARCH



PROCEDURE: Words related to balloons are hidden in the puzzle. They may be either across or down. Can you find all of the words listed?

Balloon
Blimp
Helicopter
Biplane
Parachute
Gliders
Kites

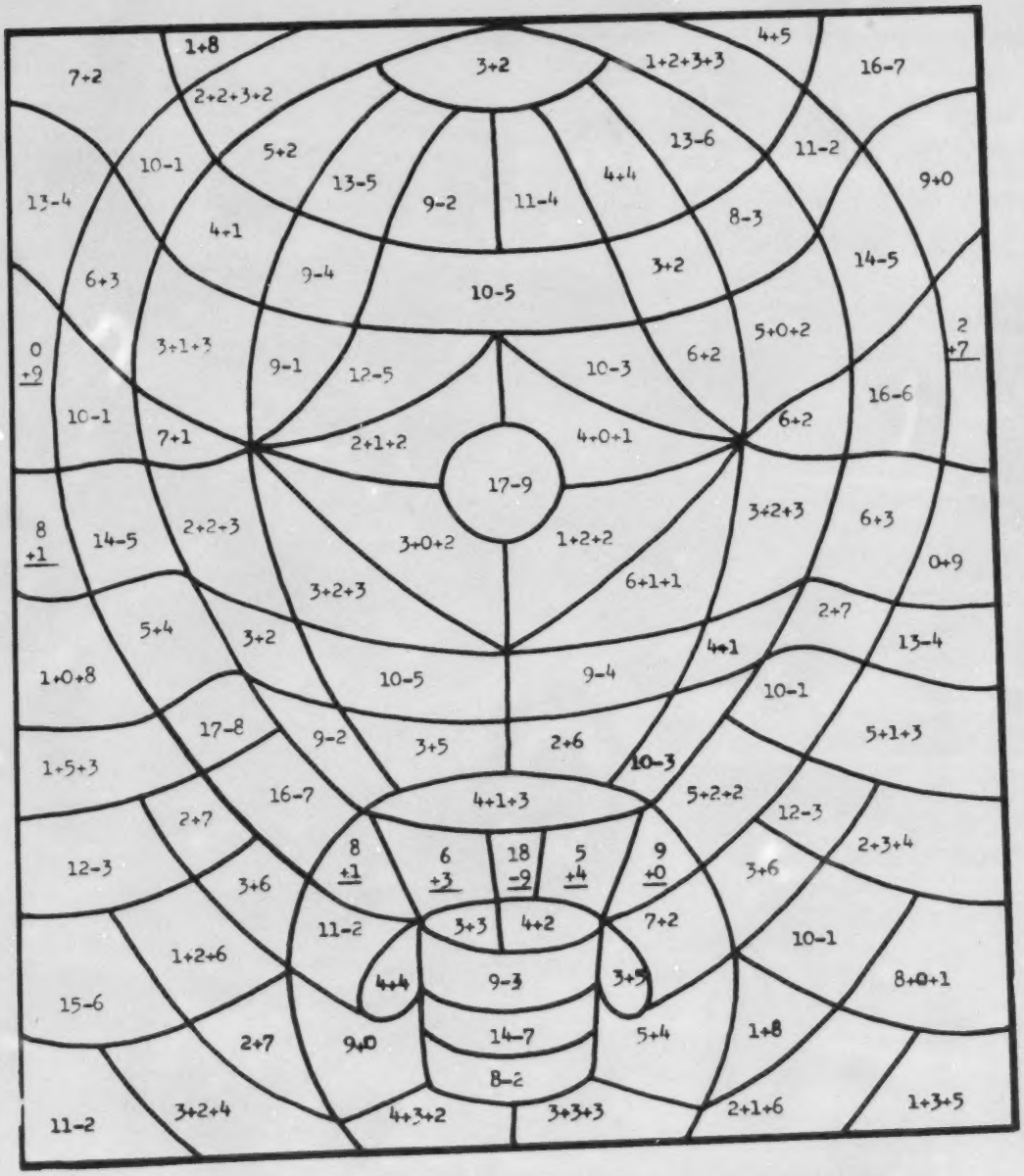
Jet
SST
Airplane

TITLE:	Hidden Aircraft
CONCEPT:	Mathematical skills can be improved by using aerospace education.
PURPOSE:	To develop skill in mathematical computation

MATERIALS: activity sheet
pencil or crayons

PROCEDURE: Students are to work the math problems then color the picture as desired.

HIDDEN AIRCRAFT ACTIVITY SHEET



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TITLE:	View from an Airplane
CONCEPT:	Visual perceptions are different from the air than from the ground.
PURPOSE:	The children will learn the song and will provide responses that tell what they might see from an airplane.

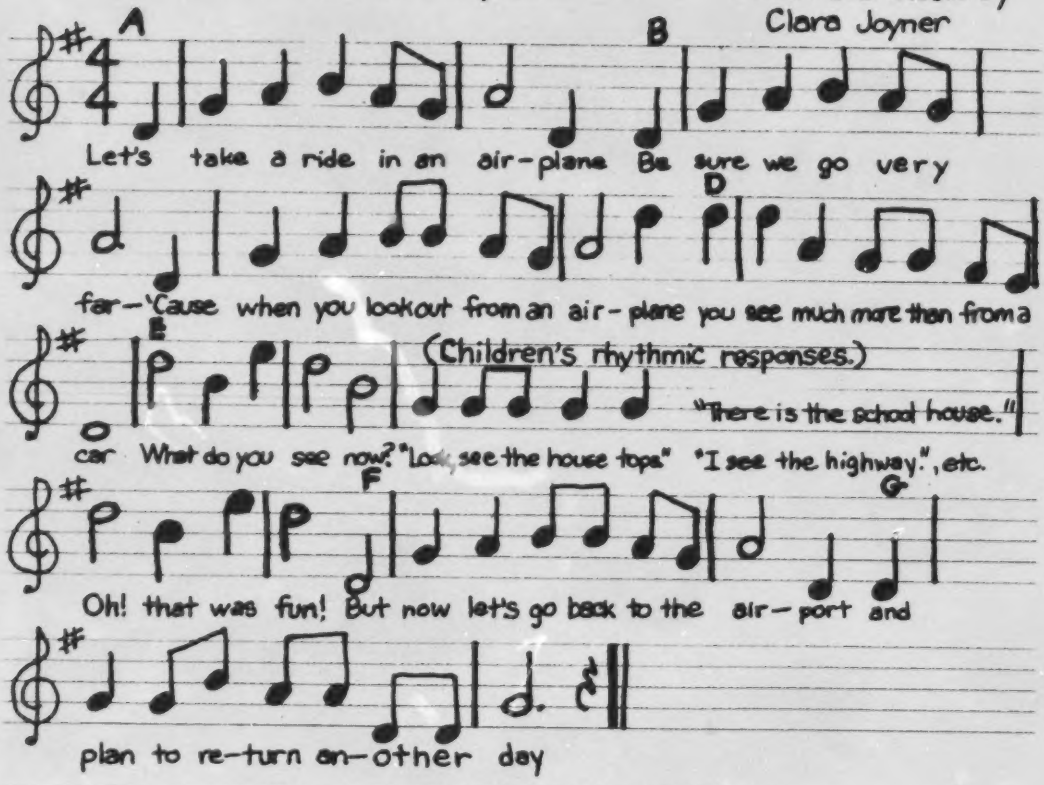
MATERIALS: song, "View from an Airplane"

PROCEDURE:

1. Teach words and music by rote method, then add in rhythm and imaginative responses to the questions asked in the song.
2. An example of response phrases will be given in the rhythm pattern such as: "Look, there's a steeple" or "Look at the rooftops." The students will suggest others.
3. The class will sing the song together without loss of a beat. Individuals will respond to the question, one after another, when they indicate readiness.

View From An Airplane

Words and music by
Clara Joyner


A
B
D
E
F
G
Let's take a ride in an air-plane Be sure we go very
far-'Cause when you lookout from an air-plane you see much more than from a
(Children's rhythmic responses.)
car What do you see now? "Look, see the house tops" "I see the highway.", etc.
"There is the school house."
Oh! that was fun! But now let's go back to the air-port and
plan to re-turn an-other day

TITLE:	Aircraft and Spacecraft
CONCEPT:	There are many kinds of aircraft and spacecraft.
PURPOSE:	Students will learn the names and characteristics of aircraft and spacecraft by matching pictures to names and descriptions of the aircraft.

MATERIALS: worksheets
pencils

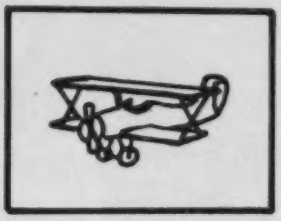
PROCEDURE:

1. Distribute copy of each worksheet to students.
2. Students should complete worksheet according to instructions given.

AIRCRAFT AND SPACECRAFT

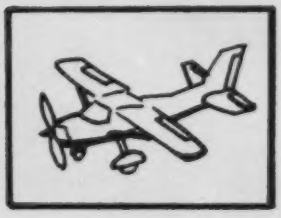
Copy the word from the list that matches the drawing. Cut out drawings and match them with the description on the next page. Paste in place.

helicopter monoplane shuttle
biplane rocket balloon



b _ _ _ _ _ _ _

r _ _ _ _ _ _



m _ _ _ _ _ _ _ _ _

s _ _ _ _ _ _ _

h _ _ _ _ _ _ _ _ _ _

b _ _ _ _ _ _ _

AIRCRAFT AND SPACECRAFT

A monoplane is a plane with one wing.

Some balloons are filled with hot air.

A helicopter has a wing that turns.

A biplane is a plane with two wings.

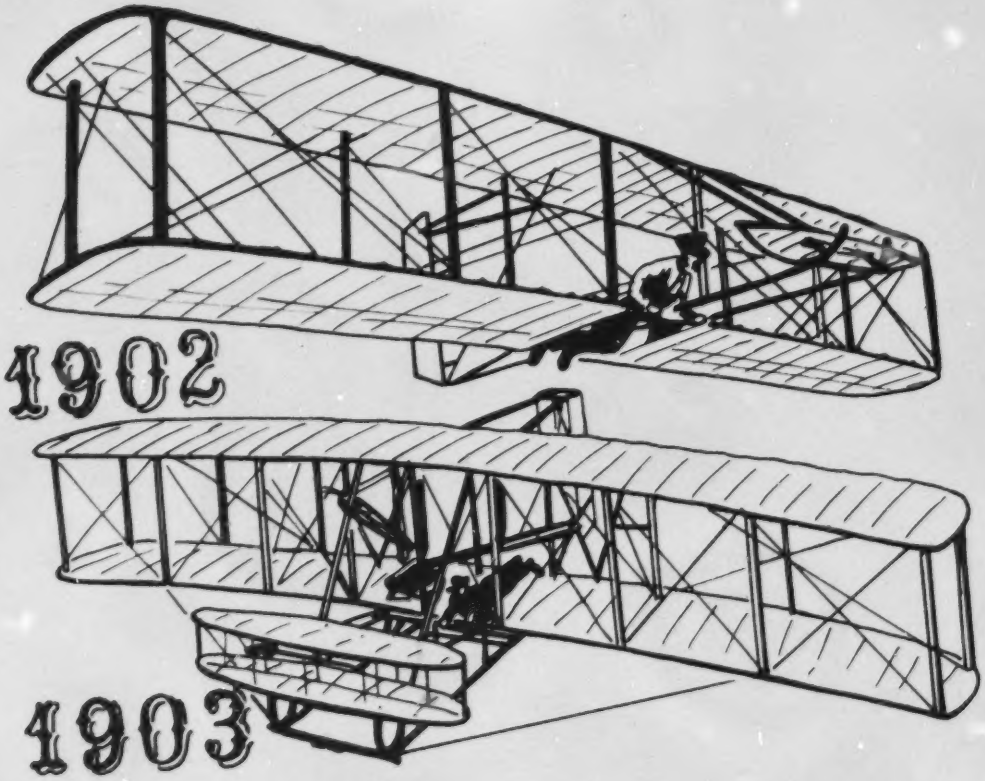
A rocket lifts things into space.

The space shuttle will carry people into space.

TITLE:	Aerospace Word Search
CONCEPT:	Aerospace terminology can become a part of the students' expressive and receptive vocabulary.
PURPOSE:	Learning aerospace vocabulary can be reinforced by use of word search fun sheets

MATERIALS: word search sheet
pencil

PROCEDURE:
1. Distribute copy of word search activity sheet to each student.
2. Instructions for completion of the activity are on the word search sheet.



AEROSPACE WORD SEARCH

Words related to aerospace are hidden in the puzzle either across or down. Can you find all of the words listed?

K E L E V A T O R N
I G W O P R E F K S
T L I R R O C A I G
T B L V O G R E T W
Y E B I P L A N E R
H F U L E I M G S I
A J R L L D T I L G
W R A E L E X N W H
K F L Y E R A E C T
K D I K R U D D E R

ELEVATOR	RUDDER	WRIGHT	PROPELLER
BIPLANE	KITTY HAWK	WILBUR	GLIDER
FLYER	KITES	ORVILLE	ENGINE

TITLE:	How is an Airplane Like a Bird?
CONCEPT:	Men copied the bird to achieve flight.
PURPOSE:	To observe and describe similarities between birds and planes

MATERIALS: pictures of airplanes and birds in flight

PROCEDURE:

1. Compare pictures, then write or tell how an airplane is like a bird. For example:
   a. They have bodies.
   b. They have a flat tail.
   c. They have wings.
   d. They have "feet" (landing support).
2. After discussion of similarities between birds and planes, students will be able to list at least four ways that men copied the bird to achieve flight.

TITLE:	Weather Pictures
CONCEPT:	Children learn about weather and related cloud patterns.
PURPOSE:	To teach different types of weather conditions

MATERIALS:
construction paper
drawing paper
crayons
paint
chalk

PROCEDURE:

1. Begin with a discussion of sky conditions on a very basic level.

   Examples:

   a. What does the sky look like just before a big storm?

   b. What does the sky look like when it is full of lightning?

   c. What does the sky look like after rain?

2. After the discussion, lead children into creating a picture of a sky for various weather conditions, such as: "Lightning and Rain," "The Storm Gathers Above Us," or "Cold and Snow in Winter."

TITLE:	Air Moves
CONCEPT:	The movement of air can be illustrated by using strong fragrances on cotton balls.
PURPOSE:	As students see hands go up around the room they can trace the flow of air.

MATERIALS:
strong perfume
cotton balls

PROCEDURE:

1. Put perfume on a piece of cotton.
2. Ask the students to raise their hands as soon as they smell the perfume.
3. Explain air currents and movement.

TITLE:	Safe Landing!
CONCEPTS:	Parachutes slow the speed of falling objects.
PURPOSE:	By comparing the time it takes for an object to reach the floor when dropped from equal heights, the student will observe that shapes affect resistance to air.

MATERIALS: cloths cut or torn in squares about handkerchief size (can use old handkerchiefs)
four strings for each student
small objects that can be tied to the string

PROCEDURE:

1. Use string tied to the four corners of old handkerchiefs (or squares of any old cloth) to attach to any kind of small object (toy cars, toy soldiers, etc.)

2. Drop two similar objects from the same height, one tied to the parachute, the other free fall.

FOLLOW-UP: Discuss the role the parachute plays in the safety of jumping from airplane.

Variations: Have students experiment with different types of material for the parachutes. Try different shapes of parachutes.

TITLE:	Variations in Gases
CONCEPT:	Different gases exhibit different properties.
PURPOSE:	The student will be able to observe the variations in the behavior of three different gases when put in balloons.

MATERIALS:

carbon dioxide (dry ice, which can be obtained from ice cream packing plant, to be handled with tongs only)
helium or helium-filled balloons
balloons

PROCEDURE:

NOTE: This is a demonstration by the teacher as students should not handle dry ice.

1. Using heavy gloves and tongs, insert a piece of dry ice into a balloon, tie the top.

2. Have students blow air into their balloons and tie.

3. If you have a tank of helium available to you, fill a balloon for each student with the helium.

4. Students will observe the carbon dioxide filled balloon expands and remains on the floor, the air-filled balloons will move about easily, remaining aloft briefly, the helium-filled balloons will quickly rise to the ceiling.

FOLLOW-UP:

If you have enough helium-filled balloons for each student, attach a card to the balloon giving student's name and address and request the card be returned by mail giving location found. This will let the student know how far the air carried the balloon and the wind direction at the time the balloon was launched.

TITLE:	Who's Who in the History of Flight
CONCEPT:	The students will be able to identify persons important in aviation history.
PURPOSE:	To research the accomplishments of persons prominent in aviation history

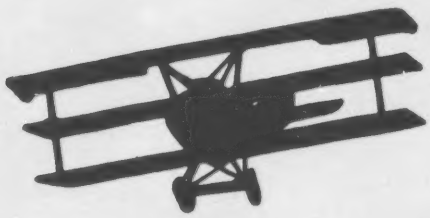
MATERIALS:
index cards
pen or pencil
reference materials such as the encyclopedia

PROCEDURE:

1. Have each student briefly identify each person listed below on a separate index card, concentrating on name, events, dates, and nationality.
2. Using the information furnished by the students, develop a class set of cards and arrange them according to date.
3. Study the cards to become familiar with names, dates, etc.
4. Use the Name Game activity as a follow up.

Who's Who in the History of Flight

Doolittle, James H.
Lilienthal, Otto
Kelley, Oakley G.
Post, Wiley
Rodgers, Calbraith R.
Wright, Orville
Earhart, Amelia
Lindbergh, Charles
Macready, John A.
Montgolfier, Etienne and Joseph
Wright, Wilbur
Yeager, Charles



TITLE:	Space Messages
CONCEPT:	Students will develop vocabulary and writing skills by writing messages to outer space.
PURPOSE:	To compose a "space message" from earth

MATERIALS:
paper
pencil
reference books

PROCEDURE:

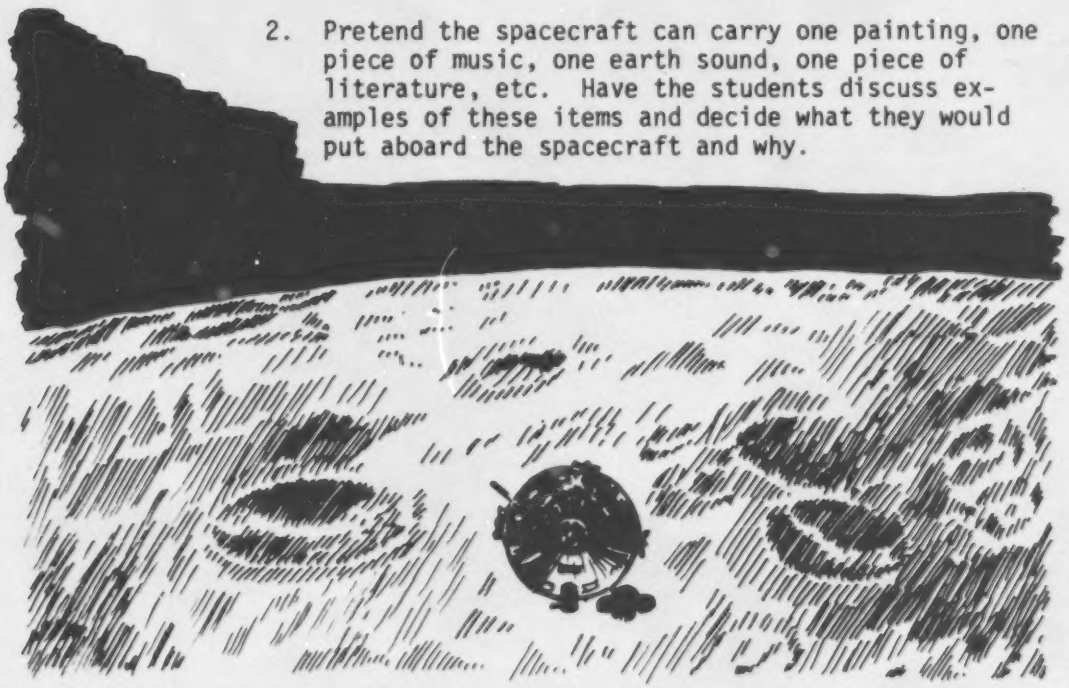
1. Have the students compose a message that will be put on a spacecraft going into outer space. The message should be simple, but at the same time reveal the source of the message, the nature of earthmen, etc. There are several media that could be employed:

   a. graphic

   b. written

   c. music or other recorded sounds

2. Pretend the spacecraft can carry one painting, one piece of music, one earth sound, one piece of literature, etc. Have the students discuss examples of these items and decide what they would put aboard the spacecraft and why.



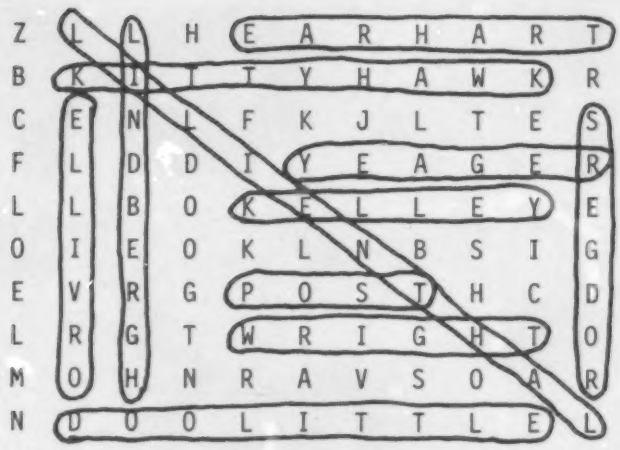
TITLE:	Name Game
CONCEPT:	The students will be able to recognize names of persons important in the history of flight.
PURPOSE:	To become familiar with names of persons important in the history of flight

MATERIALS: copy of activity sheet for each student
pencil

PROCEDURE:

1. Distribute a copy of the activity sheet to each student.
2. Have students complete the word search.

ANSWER KEY


Z L L H E A R H A R T
B K I T T Y H A W K R
C E N L F K J L T E S
F L D D I Y E A G E R
L L B O K E L L E Y E
O I E O K L N B S I G
E V R G P O S T H C D
L R G T W R I G H T O
M O H N R A V S O A R
N D O O L I T T L E L

Names to find:

Lilienthal
Post
Rodgers
Kelley
Wright
Kitty Hawk
Yeager
Lindbergh
Earhart
Doolittle

(Unlisted name: Orville)

NAME GAME

Find the hidden names in the game below. There is a name that is not in the list. See if you can find it.

Names to find:		
	Lilienthal	Kitty Hawk
	Post	Yeager
	Rodgers	Lindbergh
	Kelley	Earhart
	Wright	Doolittle

Z	L	L	H	E	A	R	H	A	R	T
B	K	I	T	T	Y	H	A	W	K	R
C	E	N	L	F	K	J	L	T	E	S
F	L	D	D	I	Y	E	A	G	E	R
L	L	B	O	K	E	L	L	E	Y	E
O	I	E	O	K	L	N	B	S	I	G
E	V	R	G	P	O	S	T	H	C	D
L	R	G	T	W	R	I	G	H	T	O
M	O	H	N	R	A	V	S	O	A	R
N	D	O	O	L	I	T	T	L	E	L

TITLE:	Pictures From Space
CONCEPT:	A computer can turn sounds into a picture.
PURPOSE:	The students will learn how pictures from spacecraft can be received on Earth.

MATERIALS: activity sheet, one for each student
pencil

PROCEDURE:

1. Follow the "bleep, blip" code to form a message from space.
2. Ask the students to make up their own space messages using the same "bleep, blip" code.

PICTURES FROM SPACE

1. Did you ever wonder how spacecraft like the Pioneer send pictures to Earth from distant planets? The sound of a picture returning from space is just a collection of strange "bleeps" and "blips." A computer is able to turn these sounds into a picture.

2. Follow the code below to make your own picture. Leave "bleep" squares blank and fill in "blip" squares with pen or pencil.

Row 1 bleep-bleep

Row 2 bleep-blip-bleep-bleep-bleep-blip-bleep-bleep-bleep-blip-bleep-bleep-bleep-blip-blip-blip-blip-bleep-bleep-bleep-blip-bleep-bleep-bleep

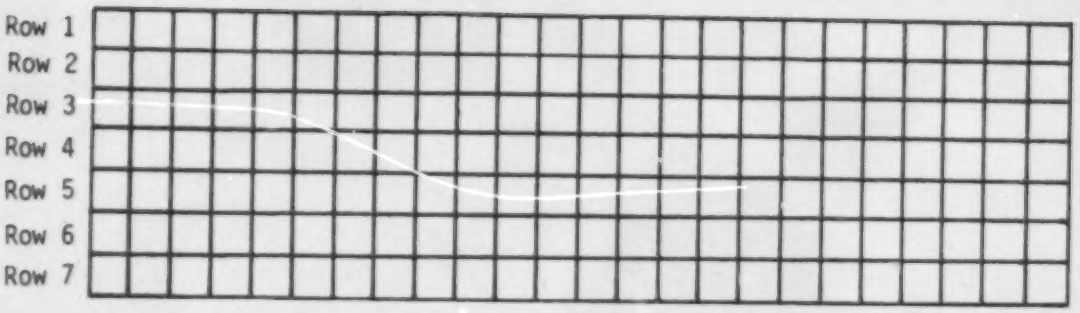
Row 3 bleep-blip-blip-bleep-bleep-blip-bleep-bleep-blip-bleep-blip-bleep-bleep-blip-bleep-bleep-bleep-bleep-bleep-blip-bleep-blip-bleep-bleep

Row 4 bleep-blip-bleep-blip-bleep-blip-bleep-bleep-blip-blip-blip-bleep-bleep-blip-blip-blip-blip-bleep-bleep-blip-blip-blip-bleep-bleep

Row 5 bleep-blip-bleep-bleep-blip-blip-bleep-blip-bleep-bleep-bleep-blip-bleep-bleep-bleep-bleep-bleep-blip-bleep-blip-bleep-bleep-bleep-blip-bleep

Row 6 bleep-blip-bleep-bleep-bleep-blip-bleep-blip-bleep-bleep-bleep-blip-bleep-blip-blip-blip-blip-bleep-blip-bleep-bleep-bleep-blip-bleep

Row 7 bleep-bleep



You were able to write NASA by following the code. The computer follows a code to construct a picture in the same way.

TITLE:	Does Shape Matter?
CONCEPT:	The shape of an object can reduce air resistance.
PURPOSE:	The students will compare the speed of falling objects.

MATERIALS: two pieces of construction paper for each student

PROCEDURE:

1. Give each student two equal size sheets of construction paper.
2. Crumple one and leave the other as is.
3. On cue, have students drop both pieces of paper.

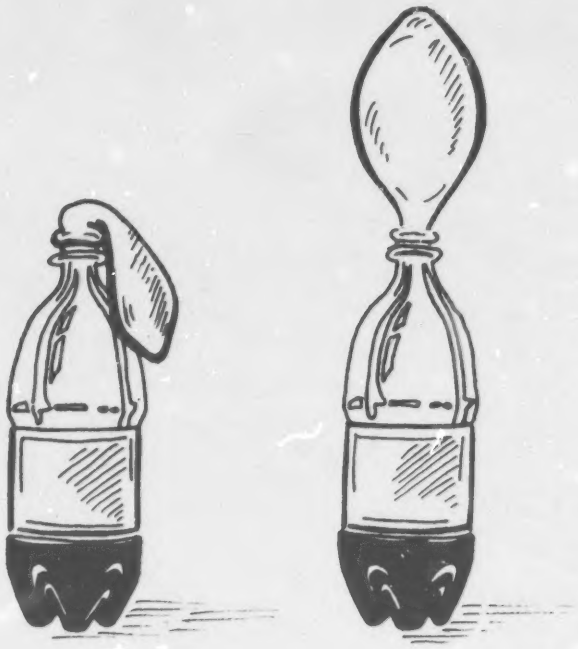
FOLLOW-UP ACTIVITY: Make parachutes, paper airplanes, kites, etc.

TITLE:	The "Growing" Balloon
CONCEPT:	Heat causes air molecules to move farther apart.
PURPOSE:	To observe the expansion of air in a bottle covered with a balloon

MATERIALS: balloons and bottles

PROCEDURE:

1. Distribute the bottles and balloons to each student or groups of students.
2. Have them determine that there is only air in each. Place the mouth of the balloon over the opening of the bottle.
3. If you have enough space near a sunny window, just leave the bottles sitting in the sun until students notice change taking place. If it is winter when your heat source is on, you might place them near or over your hot air vent.



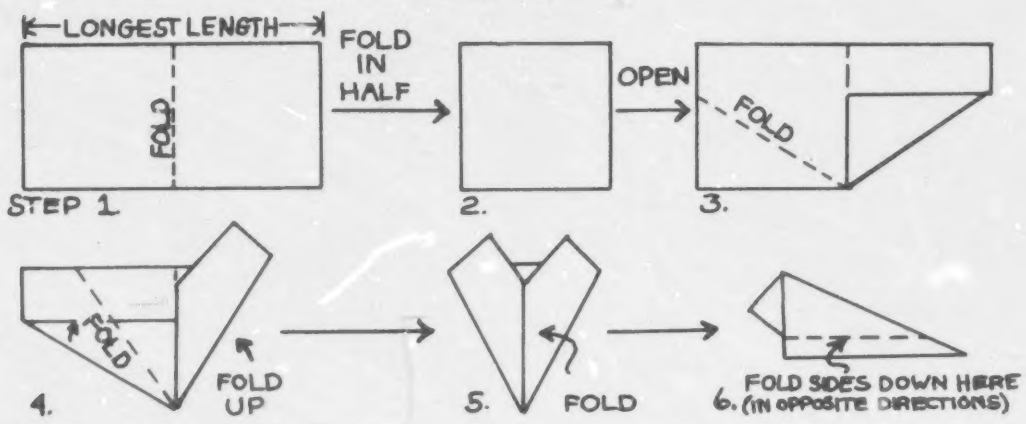
TITLE:	Paper Airplanes
CONCEPT:	Various airplane designs will demonstrate different flight principles.
PURPOSE:	Demonstration of flight principles

MATERIALS:
flat paper sheets (scrap paper)
paper clips (for balance)
cellophane tape
glue or stapler

PROCEDURE:

1. Have the students fold an airplane of their own design.
2. Test fly the planes.
3. Modify the design, if necessary.
4. Participate in the following contests:
   a. Accuracy: Winner must fly the farthest along a straight line.
   b. Duration: Winner must stay aloft the longest.
   c. Aerobatic: Winner must perform a maneuver named by the student before the launch.
5. Award prizes to winners in each category.

SAMPLE PAPER AIRPLANE:



TITLE:	Go Fly a Kite
CONCEPT:	Flying kites is fun at any age.
PURPOSE:	To learn the principles of flight

MATERIALS:

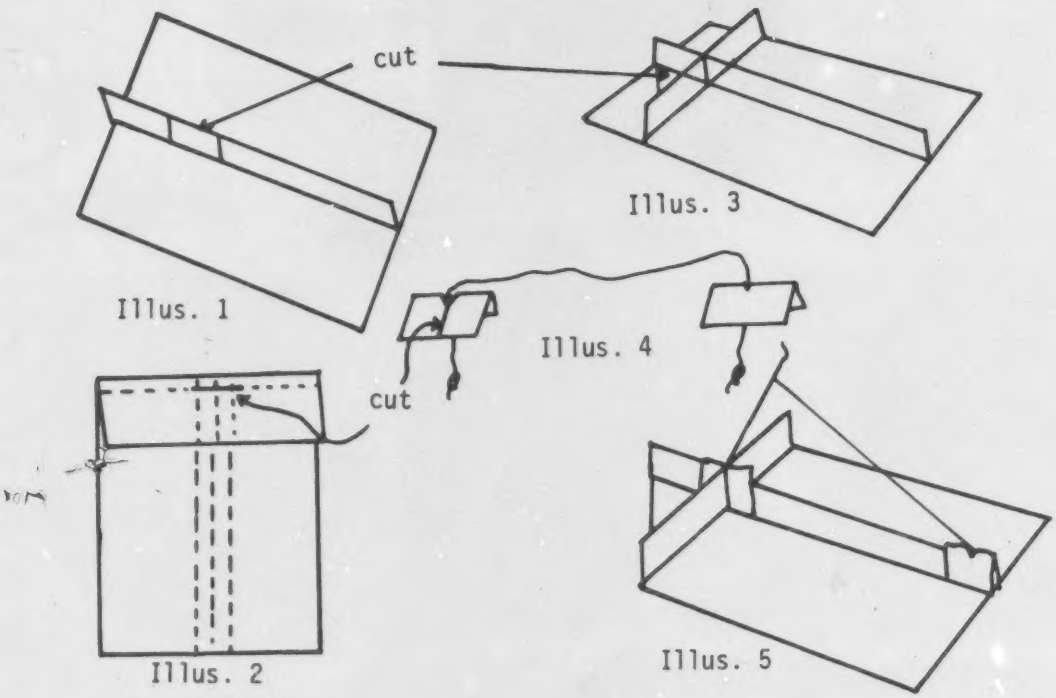
stiff paper (butcher paper) 30 cm X 40 cm for each student
paper scraps for bridle
toothpick
light string or crochet thread
crepe paper for tail
glue

PROCEDURE:

1. Distribute supplies to each student.
2. Explain how kite is to be constructed, one step at a time.
3. When all kites are completed, select day, time, and place for kite flying contest.
4. Give prizes for highest, one going furthest, etc.

GO FLY A KITE

DUTCH KITE



1. Fold and crease the paper the long way. Fold and crease again (2cm) from center fold. Open so the folded section forms a ridge up the kite. (Illustration 1)

2. Open paper flat. Fold and crease on a line (8cm) from the top (short way). Fold and crease (2cm) from this fold. Unfold this crease and cut on heavily marked lines at the top. (Illustration 2) Open paper flat, back side up.

3. Brush glue on the top and bottom sections of the long middle fold (between fold lines) but not on the cross-fold section where the H-shaped slit is located. Fold in center, spreading sides out flat, as in Illustration 1, thus gluing the spine of the kite. The cut flaps on the cross fold should slide over each other, one coming out on top of the kite, the other on the back.

4. Glue these flaps down (across the slit) on front and back of kite.

5. On the back, brush glue on the cross-fold area. Bring together to form the cross ridge. Trim corners off top edges. (Illustration 3)

6. To make the bridle, take two scraps of paper, each 5cm X 5cm, and fold in the middle across the (5cm) dimension. Fold the other way and snip a small corner off the center fold making a hole in the center of the paper. Open up. On one piece, cut about (2cm) up the middle fold. (Illustration 4)

7. Over the top joint of the kite spine (parallel to the spine), glue the paper with the slit which separates to fit over the cross ridge. The other end of the bridle is glued over the center ridge at the bottom of the kite. (Illustration 5)

8. A simple way to set the bridle angle on a light kite is to slip a finger through the bridle string so it forms a right angle with the kite at the juncture of the upright and cross ridges. With the other hand, pinch off a loop in the string, bringing it together about two inches from the top angle. Tie a loop.

9. To make the tail, glue a 1m X 2.5cm strip of crepe paper to the bottom center back of the kite. If the wind is strong and the kite flies erratically, add more tail. If wind is very light and kite will not rise, cut off a little.

10. Tie the flying line through the bridle loop.

Variations: Using the three-to-four ratio, this kite can be made in sizes down to 8cm X 12cm (onion skin paper). Pocket-size kites will fly if the wind is right and the flier is skillful.

* * * * *

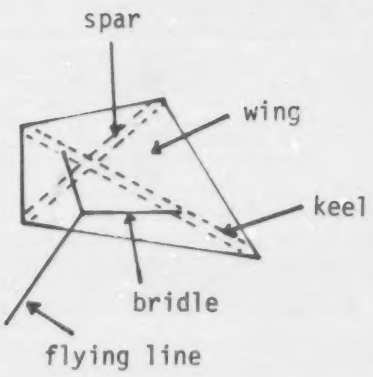
FLAT KITE

MATERIALS:
string
glue
tape
kite sticks
paper or plastic

PROCEDURE:

1. A flat kite may be constructed by securing sticks in the manner shown and attach to paper or plastic.
2. Attach a string from the end of each spar to the end of each keel.
3. Cover the frame with glue or tape.
4. Attach the bridle and flying line.

BASIC FLAT KITE



TITLE:	Aviation and Space Collage
CONCEPT:	A collage is an interesting way to display pictures of related items.
PURPOSE:	To familiarize the student with rockets, spacecraft, aircraft, and persons associated with aviation and space flight.

MATERIALS:

poster board
glue
scissors
pictures relating to space, rocketry, space exploration and aviation

PROCEDURE:

1. Locate a large variety of pictures relating to space.

2. Trim the picture edges.

3. Paste or glue the pictures in mosaic fashion to the poster board, slightly overlapping some of them.

   NOTE: A single collage may have several subject areas such as:

   stars, moon, planets, etc.
   rocket engines, rockets, launches, satellites
   drawings of early-day flying machines, probes
   manned spacecraft
   persons associated with rocketry, space flight and aviation
   aircraft

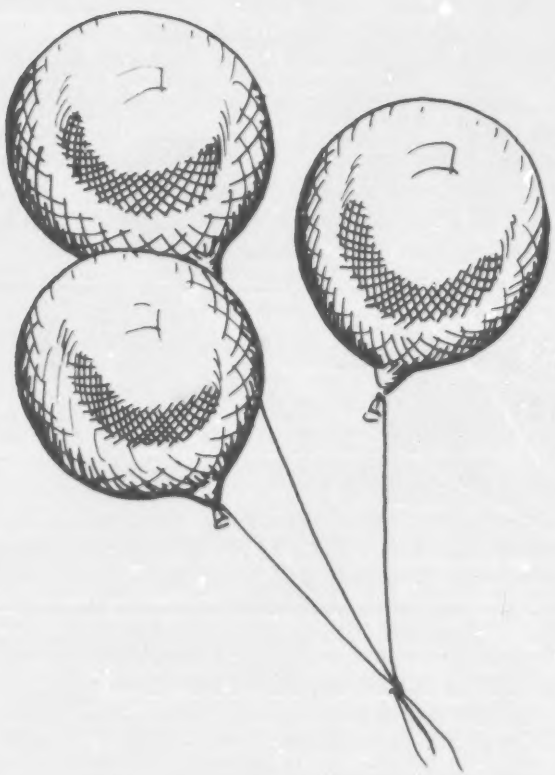
The completed project will be an attractive display in the school.

TITLE:	Airport Noun Word Search
CONCEPT:	Aerospace terminology can become a part of the students' expressive and receptive vocabulary.
PURPOSE:	Learning aerospace vocabulary can be reinforced by use of word search fun sheets

MATERIALS: word search sheet
pencil

PROCEDURE:

1. Distribute copy of word search activity sheet to each student.
2. Instructions for completion of the activity are on the word search sheet.



AIRPORT NOUN WORD SEARCH

Words related to airports are hidden in the puzzle. They may be forward, backward, up, down, or diagonal. Can you find all of the words listed below?

G F D L M P A Q M C A E T R C M N M E N
A T I C K E T S T Y R M E L C J K D F O
O M L A J P T E A F R P L U G G A G E T
B A G G A G E W G I T A E C H W F X E I
B O R C W X N P Y S W L V O R O X Y I U
Y N T Y V U D K E K U K I U G R F U E L
S K R H R V A I E T O A S G C V A C S V
P W A I C T N A A E S U I T H E X V U A
E P I K G Y T O W E R K O I O T S O E M
A S N P X O S U N J V S N S P E I J U H
K I E O V N W A I O B D I Q P N V V I T
E R R T D E L I S M X K P E O P L E U S
R K S S E P L N O C D F L E R S W N M W
S Q F Z R A Z K U H A N G A R X I P O O
B E R I Z Q X F O I K W U Z P B K E B M
U U A Q R P V B A L L O O N S I N E I E
H M M J L L P A Q D T G A G A I L J E N
G H Z C D F E Y N R M D L G H D O O A H
S T E W A R D S G E E F M A I L P V T E
K R Z L F O J U F N M Z R U A L Q S D S

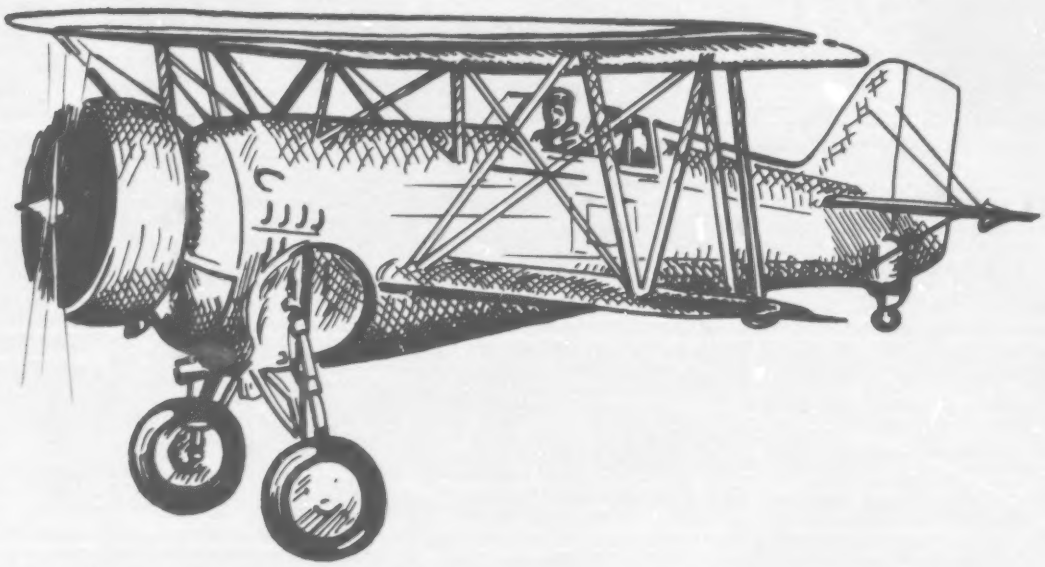
Balloons
Mail
Luggage
Attendants
Tower
Trainers
Television
Baggage
Airplanes
Tickets
Pilots
Speakers
People
Stewards
Runway
Hangar
Lights
Fuel
Men
Women
Children

TITLE:	Those Magnificent Men and Their Flying Machines
CONCEPT:	We can learn the history of planes and the men who flew them.
PURPOSE:	To research and report on an aircraft or type of aircraft

MATERIALS:
model kits
pictures
reference materials

PROCEDURE:

1. Students will build a model aircraft or find a picture of one.
2. They will research their aircraft and who flew it, what records did it break, what purposes did it serve, etc.
3. Each student will demonstrate, display, and give an oral report on the aircraft.



TITLE:	It's Magic
CONCEPT:	Air pressure can be used to move objects.
PURPOSE:	Students will move a heavy object using only increased amounts of air.

MATERIALS:
plastic or paper drinking straw
plastic bag (sandwich size)
textbook

PROCEDURE:

1. Give each student the above listed materials.
2. Student is to determine how to move the book using only the materials provided.

   NOTE: Book can be raised by placing the plastic bag under the book, inserting straw, closing end of bag tightly, then blowing air into the bag.

FOLLOW UP:
Find pictures illustrating other ways air pressure has been used to lift or move objects.

Film: "Air and How We Use It"

TITLE:	Imagination Leads to Invention
CONCEPT:	Science fiction books reflect futuristic thinking on the part of the author.
PURPOSE:	To make the students aware of possible inventions of the future

MATERIALS:
science fiction books by Jules Verne
paper for each student
pencil for each student

PROCEDURE:

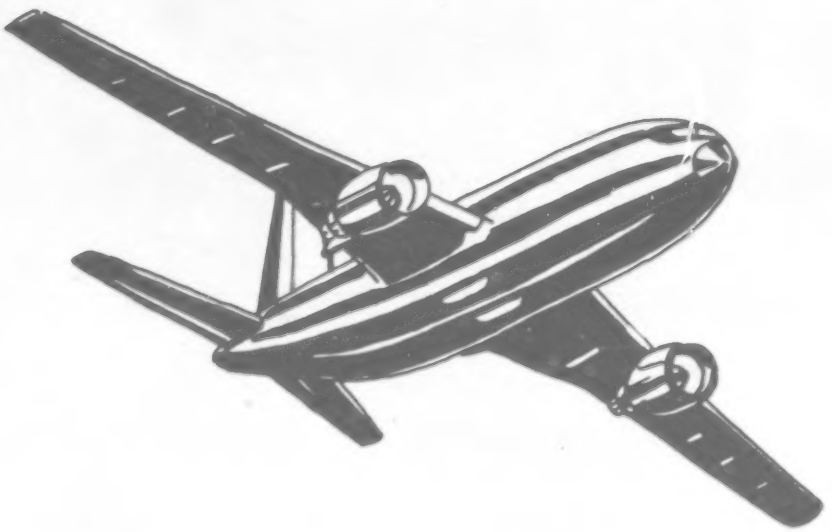
1. Have students read any one of Jules Verne's science fiction books.
2. List and discuss any inventions related to aerospace.
3. Write a narrative about your feelings if you lived during the time period given in the book.
4. Other science fiction books, comic books, etc., can be utilized in the same way.

NOTE: Recommend teacher pre-screen books to be used.

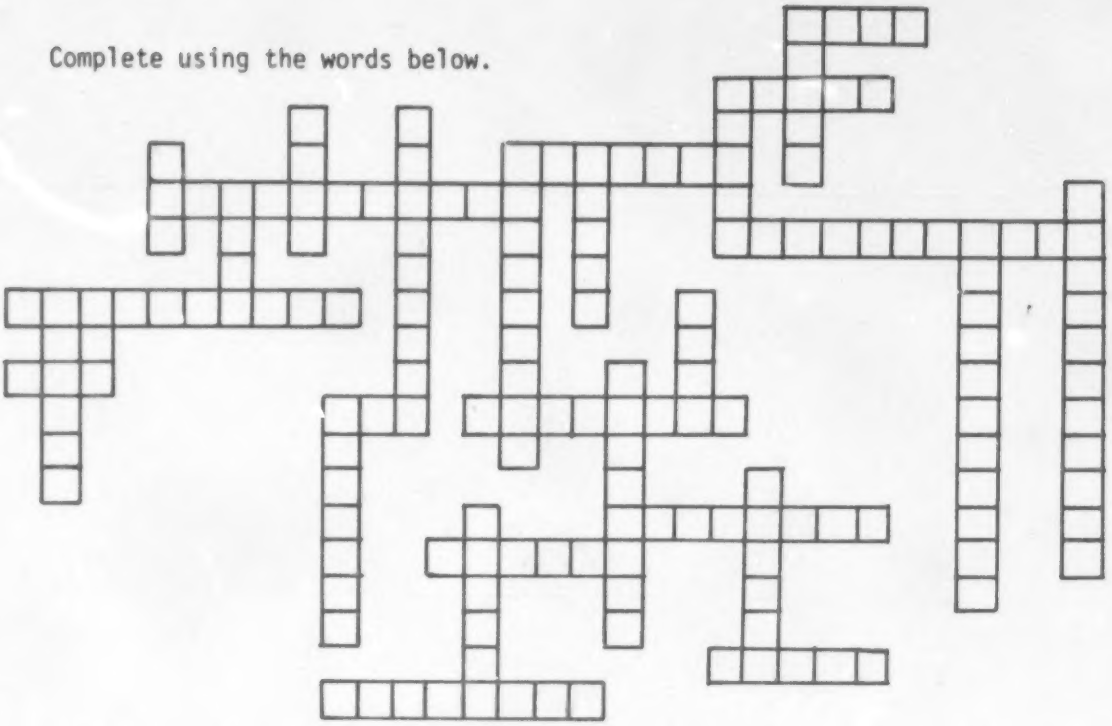
TITLE:	Word Game
CONCEPT:	Use of aeronautical terms will reinforce understanding
PURPOSE:	Have fun with aerospace words

MATERIALS: game sheet, one per student
pencil

PROCEDURE:
1. Distribute copy of game sheet to each student.
2. Allow students to work the puzzle.



Complete using the words below.



3

FLY
AIR
SKY
YAW

4

WIND
ROLL
DRAG
SOLO
LIFT

5

SPACE
PLANE
RADAR
PITCH
STALL

6

FLIGHT
GLIDER
ROCKET

7

AIRPORT
AIRFOIL

8

FUSELAGE
ELEVATOR
APPROACH
AILERONS

9

ALTIMETER
ASTRONAUT

10

VISIBILITY

11

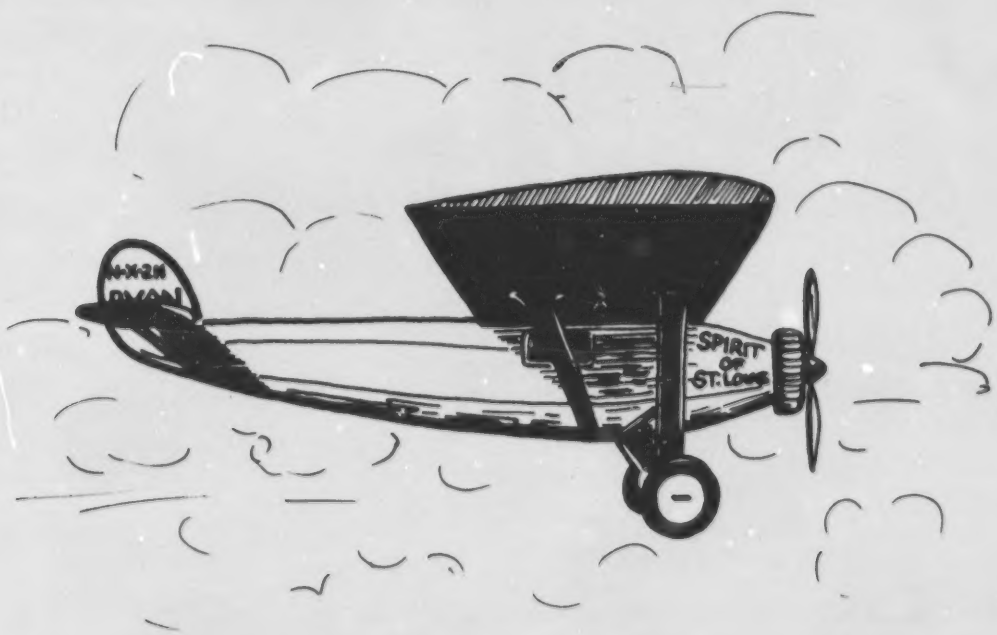
AERONAUTICS
HELICOPTER
PRESSURIZED
PLANETARIUM

TITLE:	Secret Messages
CONCEPT:	Learning math facts can be reinforced by practice.
PURPOSE:	The matching of answers to corresponding letters reveals the secret message and enables the students to check their work.

MATERIALS: worksheets
pencils

PROCEDURE:

1. Distribute copy of each worksheet to students.
2. Instruct students to match the answer to the math problem with the key printed at top of page to find the secret message.



SECRET MESSAGE

A	B	C	D	E	F	G	H	I	J	K	L	M
1	3	5	7	9	11	13	15	17	19	21	23	25

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
2	4	6	8	10	12	14	16	18	20	22	24	26

20+3 8+9 9-7 4+3 2+1 6+3 5+5 7+6 7+8

20+5 8-7 2+5 7+2 7+7 9+6 18-9

6+5 9+8 6+4 7+5 6+8 6+6 8-4 21+2 2+2

6-4 7-3 1+1 9+3 5+9 9-5 10-4

9+2 21+2 10+7 5+8 8+7 3+6

7-6 3+2 7+3 9-5 4+8 5+7 7+7 9+6 18-9

9-8 6+8 20+3 13-12 18-16 5+9 9+8 8-3

8-4 10-5 3+6 8-7 2+0 7+4 2+8 5-1 20+5

10-8 8+1 10+10 20+4 10-6 9+1 20+1 9+5 8-4

3+3 16-15 8+2 8+9 8+4

T-25	L-30	W-85	V-46	M-75	O-86	F-92
C-10	E-35	R-12	G-18	B-38	U-40	A-100
H-5	P-64	I-55	N-70	D-80	S-50	

Put the correct number and letter under each problem.

20	10	20	63	24	20	9	5	35
+5	-5	+15	+22	-12	+35	+9	+0	-10
____	____	____	____	____	____	____	____	____

26	9	42	45	9	14	36	30
+12	+3	+44	-20	-4	+21	-24	+20
____	____	____	____	____	____	____	____

50	60	20	30	10	25	25
+25	+40	+60	+5	+15	-20	+10
____	____	____	____	____	____	____

71	23	6	40	45
+21	+32	+6	+10	-20
____	____	____	____	____

60	20	20	60	45	90	40	80	80	70
-10	+20	-10	-50	-10	-40	+10	+12	-40	-40
____	____	____	____	____	____	____	____	____	____

50	51	40	65	9	60	48	85	24	95	50
+14	+35	+45	-30	+3	+20	-36	-30	+22	-60	+20
____	____	____	____	____	____	____	____	____	____	____

81	70	50	10	45	13
+11	-40	+5	+8	-40	+12
____	____	____	____	____	____

TITLE:	Famous Aircraft
CONCEPT:	The students will become familiar with aircraft famous in the history of flight.
PURPOSE:	To be able to identify various well-known aircraft

MATERIALS: reference books containing photographs and/or drawings of historical aircraft (encyclopedia, etc.)

PROCEDURE:

1. Locate photographs and drawings of the following aircraft:

   a. Montgolfier balloon
   b. Lilienthal glider
   c. Wright 1903 Flyer
   d. "Vin Fiz" (Cal Rodgers, pilot)
   e. Ford Trimotor
   f. Douglass DC-3
   g. "Spirit of St. Louis"
   h. Lockheed Vega "Winnie Mae"
   i. Lockheed Vega (Amelia Earhart)
   j. Bell X1
   k. North American X15
   l. Gossamer Condor (recent man-powered flight)
   m. Fokker T-2 (Kelly and Macready, pilots)
   n. Space Shuttle (Columbia)

2. Identify and give an oral or written description of the history and importance of the aircraft of your choice.

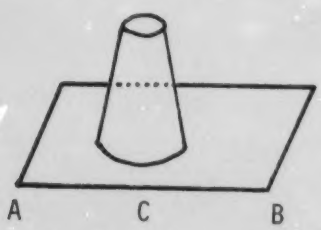
3. Extend the list by finding and identifying aircraft other than those listed.

TITLE:	Air Pressure
CONCEPT:	Air exerts a force in every direction against whatever it touches.
PURPOSE:	To better understand air pressure

MATERIALS:
water glass
water
piece of thin, flat cardboard

PROCEDURE:

1. Completely fill a glass with water.
2. Place cardboard over the glass.
3. Carefully turn the glass upside down, holding the cardboard tightly to the glass.
4. Take your hand away from the cardboard. The cardboard stays in place against the glass.
5. Tilt the glass or hold it sideways and the cardboard will remain in place.
6. Discuss air pressure.



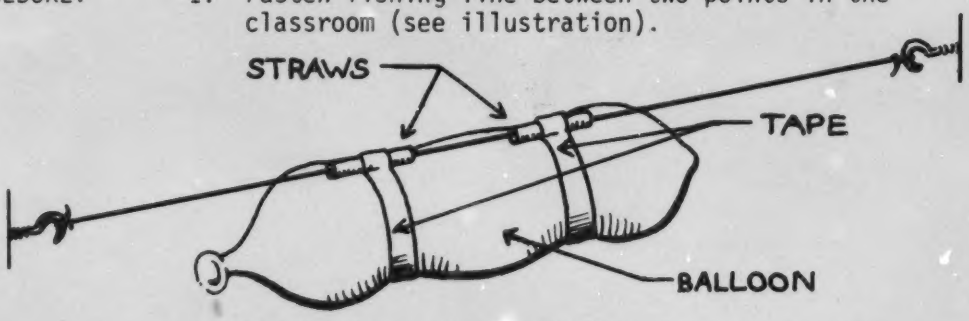
At points A and B, the upward and downward air pressure is in balance, but at C the upward pressure of air is greater than the downward pressure of water and will hold the cardboard in place.

TITLE:	Rocket Vehicles
CONCEPT:	The rocket's basic operation is based on Newton's Third Law of Motion: "For every action there is an equal and opposite reaction."
PURPOSE:	To develop concept of action and reaction

MATERIALS:
nylon fishing line
plastic straw
long balloon
tape

PROCEDURE:

1. Fasten fishing line between two points in the classroom (see illustration).



2. Hold the neck of the balloon to prevent air escaping.
3. Inflate the balloon and tape it to the straw.
4. String the fishing line through the straw while holding the neck of the balloon.
5. Release neck of the balloon and see what happens.
6. Answer the following questions:
   a. Why does the balloon move?
   b. How do you suppose this same balloon might perform in a complete vacuum?
   c. What would happen to the range of the balloon if the fishing line had a steeper incline? Why, then, do we launch rockets vertically and then arc them over into horizontal flight? (Consider air friction and speed.)

TITLE:	Science Fiction Art and Literature
CONCEPT:	The students will develop skills necessary to express his/her imagination in verbal, written, or illustrative form.
PURPOSE:	To introduce the student to the realm of science fiction and science fiction illustration

MATERIALS:

pencil
paper
various other materials for drawing and writing

PROCEDURE:

1. Allow the students to compose a short story that is science fiction in nature. The length and plot of the story should be left entirely to the discretion of the student.

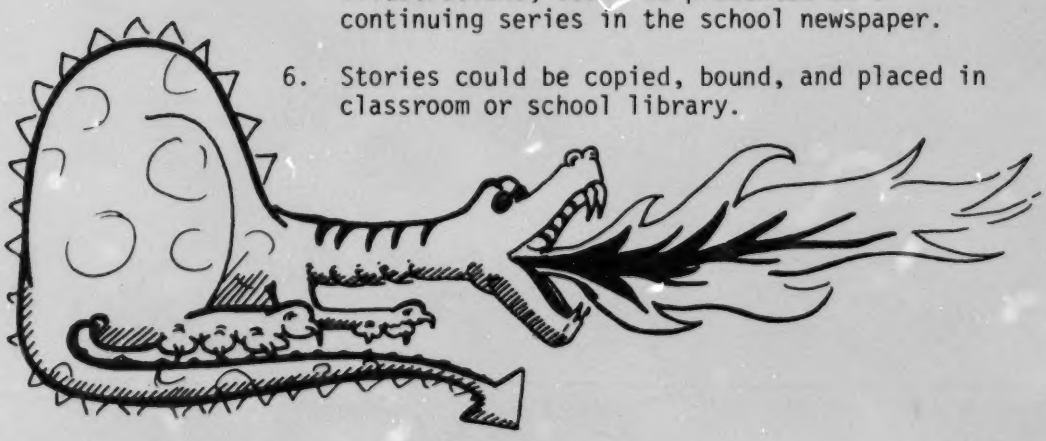
2. Each student would present a story of his/her own design or it might be interesting to "co-author" a single story as a class project.

3. Illustrate the story with drawings and/or paintings.

4. The story or stories may be presented in written or oral form, or perhaps, as a skit complete with appropriate music. The skit could be video-taped thus allowing for special effects.

5. The written story or stories, complete with illustrations, could be presented as a continuing series in the school newspaper.

6. Stories could be copied, bound, and placed in classroom or school library.



TITLE:	The Planets
CONCEPT:	The planets vary in size.
PURPOSE:	To show by means of a scale model, the relative sizes of the planets

MATERIALS:
colored paper or balls of various sizes
ruler
label
markers
tape measure

PROCEDURE:

1. Using the scale measurements below, find common items that measure approximately the same size (ping pong balls, tennis balls, beach balls, etc.).

   NOTE: It is also possible to use circles of paper cut to scale size instead of balls.

Planets	Diameter in Miles	Scale Measurement
Mercury	3,000	1 inch
Venus	7,600	2 1/2 inches
Earth	7,900	2 3/4 inches
Mars	4,200	1 1/2 inches
Jupiter	87,000	2 feet 5 inches
Saturn	71,500	2 feet
Uranus	29,500	10 inches
Neptune	27,000	9 inches
Pluto	3,600	1 1/4 inches

2. Label each ball with the name of a planet.

3. Put in order in a display.

4. Research can be done to find out the distances between the planets and a scale could be calculated for these distances. The balls could be lined up on the school ground or down the hall. (Exact scale may be difficult to achieve due to the vast distances between the planets.)

TITLE:	What Goes Up Must Come Down
CONCEPT:	Helium-filled balloons will ascend or descend depending upon air currents, wind velocity, temperature, etc.
PURPOSE:	Students will gain understanding of air currents as they relate to distance traveled by their balloon

MATERIALS: helium-filled balloons (one per student)
stamped post cards or index cards (one per student)
string

PROCEDURE:

1. Have balloons filled with helium.
   (Note: This can sometimes be done for small or no charge at nearest McDonald's Restaurant.)

2. Each student should self-address postcard giving school address. On reverse (back) of postcard, put information similar to the following:

   EXAMPLE: This balloon was released __(date)__ as part of a class experiment in aerospace education. Please detach and mail postcard after completing this information:

   Balloon was found ___(date)___,
   __(location)__ by __(name)_____
   _____.

   Thank you for your cooperation.

3. Punch hole in top left-hand corner of postcard, attach string (approximately six to eight inches in length), tie securely to balloon.

4. When all balloons, cards, etc. are ready, they should be released in unison from open area such as football field or parking lot.

5. As postcards are received back in mail, show locations on area map using map pins with student's name attached. Give prize for balloon traveling farthest distance.

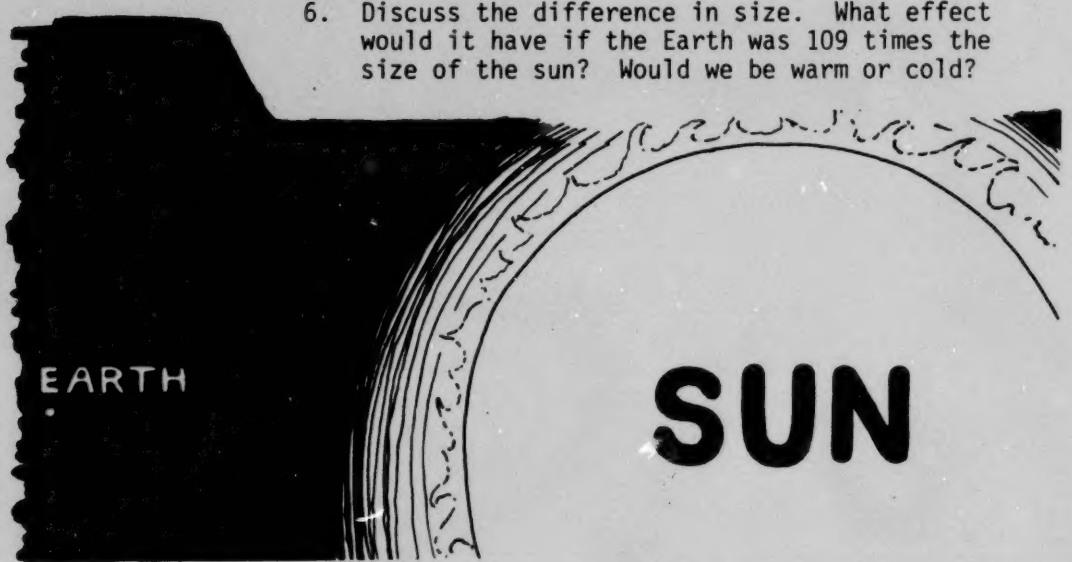
TITLE:	Comparing the Sun and the Earth
CONCEPT:	The sun's diameter is approximately 109 times greater than the Earth's
PURPOSE:	To illustrate a comparison between the size of the Earth and the sun

MATERIALS:

large sheets of paper
glue
string
pencils
bag of dried split peas

PROCEDURE:

1. Count out 109 split peas.
2. Draw a straight line across the sheet of paper.
3. Spread glue on the line and place the peas on the glue, making sure they touch each other.
4. Use the string to draw a circle around the line of peas.
5. Imagine the circle to be the sun and the peas to represent the size of the Earth.
6. Discuss the difference in size. What effect would it have if the Earth was 109 times the size of the sun? Would we be warm or cold?



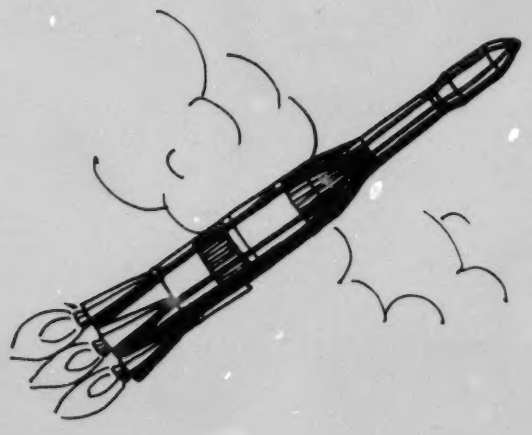
TITLE:	Lift Off!
CONCEPT:	Air pressure is a force.
PURPOSE:	Students will lift a heavier object using only air pressure

MATERIALS:

plastic bags (quart size) for each child
two rather large tables
student chair

PROCEDURE:

1. Place approximately 20 plastic bags (number depends on size of table, bags should be approximately one foot apart) between the two tables - opening toward the outside. One table is to be turned upside down on top of the other table.
2. Have a student sit in the chair placed on top of the inverted table.
3. Station students one to a bag. On the count, each student is to blow into their bag. The air should lift the table.
4. Take turns with students in the chair.



TITLE:	Night and Day
CONCEPT:	The rotation of the earth on its axis causes the periods of light and darkness that we call day and night.
PURPOSE:	The use of a flashlight to represent the sun and a globe for the earth will help the students understand the cause of day and night

MATERIALS:
flashlight
globe
small human figure or flag

PROCEDURE:

1. Demonstrate what makes day and night on earth by using a globe and a flashlight.
2. Fasten the figure or flag on the globe with a pin or adhesive.
3. Have the children observe what happens as the globe rotates and the light remains stationary.
4. Observe the shadows created by the earth's movement at different times of day by a tree or post.

TITLE:	Spaced-out T-Shirts
CONCEPT:	Students can create original designs for T-shirts to be worn for Aerospace Day.
PURPOSE:	Aerospace Day spirit will be promoted by designing and wearing T-shirts with original aerospace motifs

MATERIALS:

white or solid color T-shirt
liquid embroidery markers
heavy cardboard
pins

PROCEDURE:

1. Have students bring old T-shirts. (Garage sales and thrift shops are a good source for teachers to find shirts for those students who are unable to bring one.)

2. Insert cardboard between front and back of the shirt and pin down the area to be decorated. Don't stretch fabric too tightly or the design will be distorted.

3. Sketch the design onto the shirt with pencil. Motifs might be hot-air balloons, spacecraft, aircraft, planets, etc.

4. The designs can be colored with liquid embroidery markers according to manufacturer's directions.

5. Prizes can be awarded in categories such as: originality, color, realistic, humorous, etc.

TITLE:	What's What in the Exploration of Space
CONCEPT:	Students can become familiar with rockets, spacecraft, and associated hardware significant in the history of space exploration.
PURPOSE:	To use research to learn about spacecraft, and to be able to identify the spacecraft by photos or description

MATERIALS: various research materials
pictures of spacecraft

PROCEDURE:

1. Use reference materials to identify the following spacecraft:

Rockets

Redstone	Atlas
Jupiter C	Scout
Saturn V	V-2
Saturn I-B	Goddard 1926 rocket
Titan	Goddard 1941 rocket

Spacecraft

Explorer I	Pioneer (probe)
Sputnik	Voyager (probe)
Mercury Capsule	Lunar Orbitor
Gemini	Surveyer (moon lander)
Apollo Command Module	Mariner IX
Lunar Module	Ranger
Soyuz	

Other Craft

X-15	Bell X-1
Wright Flyer	

2. After researching the equipment, use photos to reinforce information learned.

TITLE:	Master Two-Step
CONCEPT:	Physical fitness is a prime requirement in the selection of astronauts.
PURPOSE:	The student will gain an understanding of some of the activities astronauts use to stay fit

MATERIALS: platform, approximately 20 inches high
chart for recording pulse rate
pencil
watch with second hand

PROCEDURE:

1. Students pair off. Take pulse rate of partner while at rest; record for future reference. (Teacher give instructions for proper method of taking pulse.)
2. Student steps up onto platform and down again at a brisk tempo for three minutes - approximately 18 times. (Have partner supervise and time activity.)
3. Again, take pulse rate of partner after exercise; record and compare to pulse rate at rest.
4. Wait two minutes, again take pulse and record; compare to two previous pulse rates.

PULSE RATE

Name	At Rest	Immediately after exercise	Two minutes after exercise	Three minutes after exercise

TITLE:	Construction of an Action-Reaction Engine
CONCEPT:	The rocket's basic operation is based on Newton's Third Law of Motion: "For every action there is an equal and opposite reaction."
PURPOSE:	To better understand how rockets and/or satellites change direction

MATERIALS:
water
cord
coffee can
hammer
small nails

PROCEDURE:

1. Punch a small hole in side of coffee can near the bottom.
2. Fill can with water and observe movement of can as water spurts from opening.
3. Answer the following questions:
   a. How does Newton's Third Law apply to this investigation?
   b. Relate the results of this investigation to "turning" a satellite by utilizing a liquid or gas (propellant).
   c. How can you modify the apparatus to involve steam as the propellant?

TITLE:	Various Protective Qualities of Materials
CONCEPT:	Different materials have different insulating and conductive properties.
PURPOSE:	Determine which material best maintained the original temperature and which allowed the greatest change in temperature

BACKGROUND INFORMATION:

In space, the temperature ranges from well beyond 250°F to less than -250°F. The astronaut in space, or on the airless moon, is subjected to these conditions. The space suit is designed with insulating layers to protect the astronaut from these extreme temperatures.

MATERIALS:

strips of Mylar plastic
aluminum foil
cheese cloth
Saran Wrap
masking tape
thermometers
heat lamp

PROCEDURE:

1. Fold the different materials into pouches, making each pouch identical in size and thickness.
2. Insert a thermometer into the pouch and hold under a heat lamp for four minutes at a pre-determined distance.
3. Take note of temperature at start of test and at the end of four minutes.
4. Using a bar graph, indicate temperature at start of test and at end of four minutes under heat lamp.
5. Discuss which material(s) would be best for a space suit.

TITLE:	Sock It To Me!
CONCEPT:	Windsocks are used to indicate wind direction.
PURPOSE:	The students will construct a windsock to indicate the wind direction and force

MATERIALS:

heavy cloth, about 36" X 24"
four lengths of heavy wire, about 10" each
wire coat hanger
pole, about 36" long
large nail
wooden spool
needle
heavy thread

PROCEDURE:

1. Form the hanger into a loop about nine inches in diameter.

2. Attach the four wires to this circular hoop at four equi-distant points on its circumference.

3. Cut the cloth into a sleeve (see illustration).

FIG. 1

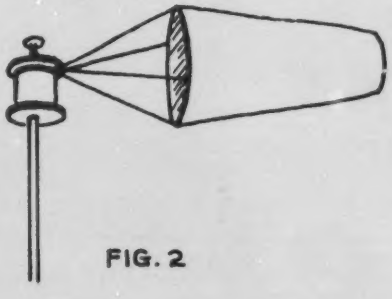


FIG. 2

4. Sew the sides together making a cone, and sew the larger ends of the cone to loop bind the exposed ends of the wires to the spool.

5. Place the nail through the spool so that the spool may pivot freely on the nail. Hammer the nail into the end of the long pole.

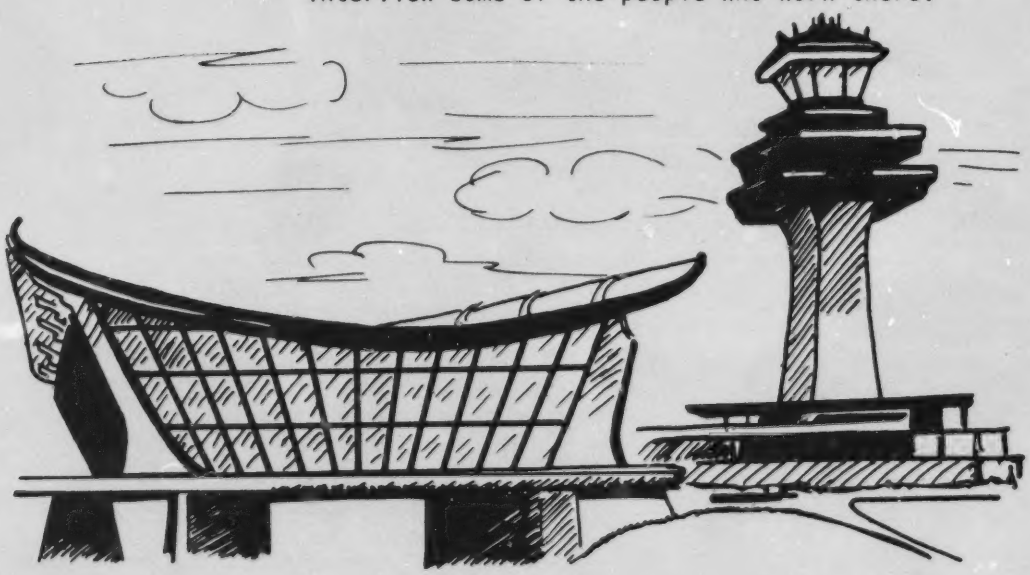
6. Place the pole outdoors and nail it to a tall post or to a rooftop, away from obstructions, so that the sock may swing freely with the wind.

TITLE:	Who Works At The Airport?
CONCEPT:	People are employed in a wide variety of jobs at an airport.
PURPOSE:	Students will become aware of the many jobs related to air travel and the people who do those jobs

MATERIALS:
books and brochures from airlines, airports, and travel agencies
pictures and posters
films and filmstrips

PROCEDURE:

1. Expose the class to airport scenes through use of films, pictures, stories, etc.
2. Discuss the services provided at a large airport and begin a list of all jobs that might be related to those services.
3. Provide resource material for students to research these jobs and add to the list. A bulletin board or scrapbook can be created by students to display pictures of workers and job descriptions.
4. If possible, visit an airport to observe and interview some of the people who work there.



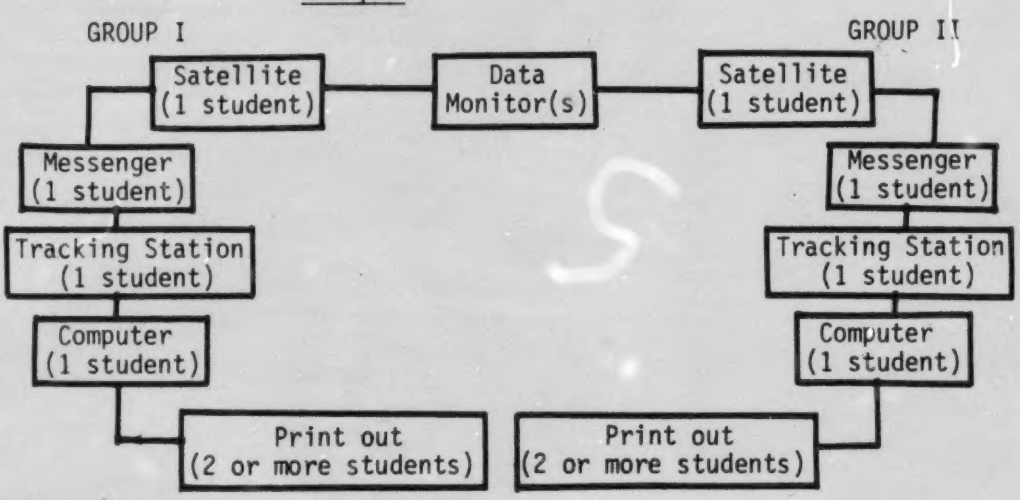
TITLE:	The Data Game
CONCEPT:	Information must be explicit to assure understanding.
PURPOSE:	To make students more aware of the importance of good communications

MATERIALS: Common articles, such as:
- chalk
- paper clips
- colored paper
- erasers
- scissors
- pencil
- pen
- etc.

PROCEDURE:

1. Divide class into equal teams of two or six. Reserve one, two, or three students to act as data monitors.
2. Team members are designated as:
   - 1-satellite
   - 1-messenger
   - 1-tracking station
   - 1-computer
   - 2 (or more)-printouts
3. Team members should be seated far enough from each other so that information received in a whisper cannot be overheard.

Example:



4. Data monitor(s) arrange the data (chalk, paper clips, etc.) in a definite pattern out of view of all print-out stations and team members.

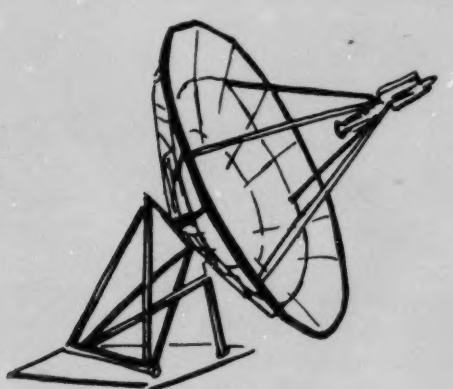
5. When students are seated in assigned locations, satellite goes to data table, observes carefully for 30 seconds, then in a whisper, reports his information to the messenger. The messenger, in turn, repeats information in a whisper to the tracking station who reports to the computer, and the computer reports to the printout station where they try to arrange their items in an exact duplicate of the original data based on information received.

   NOTE: The information exchange should be done in whispers so only the person spoken to can hear. The person receiving the information is not allowed to ask questions but may say, "Repeat, please."

6. Team wins when data printout matches pattern placed by data monitor(s).

7. Change assignments of team members and repeat as often as time will allow.

   NOTE: As team members become more proficient, they will soon learn to relate the information in short sentences or phrases. Have them use reference points in their directions, such as clock directions or compass points. A time limit may be set and points given for each item placed correctly.



TITLE:	Who's Who in the History of Flight
CONCEPT:	Many people have played important roles in aerospace history.
PURPOSE:	To research the accomplishments of individuals who are important in aerospace history

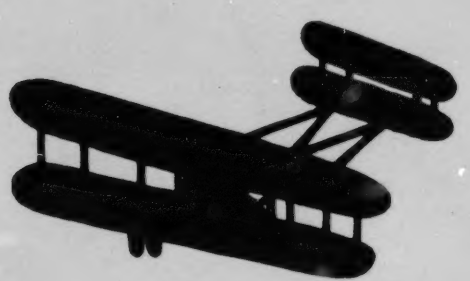
MATERIALS: Various reference sources found in school or public library
art supplies, as needed

PROCEDURE:

1. Have the students individually, or in groups, research the following people. Include the event associated with the person, the date it took place, the nationality of the person, and other important information.

   a. Orville Wright
   b. Wilbur Wright
   c. Charles Yeager
   d. John Glenn
   e. Robert H. Goddard
   f. Wernher von Braun
   g. James H. Doolittle
   h. Amelia Earhart
   i. Otto Lilienthal
   j. Charles Lindbergh
   k. Oakley G. Kelley
   l. John Macready
   m. Etienne and Joseph Montgolfier
   n. Wiley Post
   o. Calbraith P. Rodgers
   p. Neil Armstrong
   q. Count Ferdinand von Zeppelin
   r. Yuri Gagarin

2. The information could be put into reports, murals, a timeline, games, or could be placed on large, illustrated posters for use in the room.



TITLE:	"Up, Up, And Away"
CONCEPT:	Hot air balloons continue to play an important role in the world of flight.
PURPOSE:	To be able to relate specific information about hot air balloons

MATERIALS:

listening set of headphones
cassette recorder and tape of "Up, Up, and Away" by Jimmy Webb
interest center with picture of hot air balloon; activities may be printed on "clouds" and placed around the picture
resource materials needed to complete the projects

PROCEDURE:

1. Listen to the tape. Choose a designated number of activities to complete. (Activities may be modified to fit your needs.)
2. Describe the things you saw on your hot air balloon trip. Use any method you wish, such as a mural, telling a story, writing a poem, etc.
3. Write a newspaper story about the first hot air balloon ride. Pretend you were there.
4. Research the hot air balloon. Draw a diagram showing the parts of the balloon and explain their function.
5. Discover the name of the inventor(s) of the hot air balloon. Write a biographical sketch about this (these) person(s).
6. Design an insignia for the side of your balloon.
7. Organize a debate. Use the topic: "Hot Air Balloons vs. Gliders."
8. Improve either the design or the operation of the hot air balloon.
9. Build a scale model of a hot air balloon.

10. Write an adventure story about your hot air balloon.

11. Find pictures of hot air balloons. Prepare a chart showing different kinds of balloons.

12. Research to find information on laws or restrictions concerning hot air balloons.

TITLE:	International Phonetic Alphabet
CONCEPT:	The International Phonetic Alphabet is a fun way to communicate.
PURPOSE:	Students will gain a working knowledge of the International Phonetic Alphabet and will have a background interest in the communications between pilots, astronauts, control tower operators, and space capsule communicators.

BACKGROUND INFORMATION: Aerospace messages are transmitted and received by aircraft pilots, control tower operators, astronauts, and space capsule communicators. Student pilots flying light airplanes, control tower operators at small airports, airline captains in big jets, air traffic controllers at large metropolitan air terminals, and astronauts in space capsules all rely on aerospace communications to transact their business.

INTERNATIONAL PHONETIC ALPHABET (ICAO)

A	._	Alfa	(Al-fah)	N	_.	November	(No-vem-ber)
B	_...	Bravo	(Brah-voh)	O	_ _ _	Oscar	(Oss-cah)
C	_._.	Charlie	(Char-lee)	P	._ _.	Papa	(Pah-pah)
D	_..	Delta	(Dell-tah)	Q	_ _._	Quebec	(Keh-beck)
E	.	Echo	(Eck-oh)	R	._.	Romeo	(Row-me-oh)
F	.._.	Foxtrot	(Foks-trot)	S	...	Sierra	(See-airrah)
G	_ _.	Golf	(Golf)	T	_	Tango	(Tang-go)
H	....	Hotel	(Hoh-tell)	U	.._	Uniform	(You-ne-form)
I	..	India	(In-dee-ah)	V	..._	Victor	(Vik-tah)
J	._ _ _	Juliette	(Jew-lee-ett)	W	._ _	Whiskey	(Wiss-key)
K	_._	Kilo	(Key-loh)	X	_.._	X ray	(Ecks-ray)
L	._..	Lima	(Lee-mah)	Y	_._ _	Yankee	(Yang-key)
M	_ _	Mike	(Mike)	Z	_ _..	Zulu	(Zoo-loo)

How Numbers Are Spoken

Number	Sound	Number	Sound
1	WUN	6	SIX
2	TOO	7	SEV-EN
3	TREE	8	AIT
4	FOW-ER	9	NIN-ER
5	FIFE	10	ZERO

Each number is pronounced individually. The number 55397 is spoken: FIFE FIFE TREE NIN-ER SEV-EN. When numbers are combined with letters of the alphabet, the phonetic code word for each letter is spoken. Y4395 is pronounced: YANG-KEY FOW-ER TREE NIN-ER FIFE.

MATERIALS: copy of International Phonetic Alphabet for each student

PROCEDURE:

1. Students will respond to roll call with their numbers on the class roll and the code words of their initials.
2. Have students write messages in phonetic code, then trade for decoding.
3. Write instructions on chalkboard for various activities using phonetic code.
4. Let students pair off and practice sending and receiving message using dot-dash code.

TITLE:	Aerospace Words And Phrases
CONCEPT:	The language of aerospace is unique.
PURPOSE:	To help students learn to speak the language of aircraft pilots and astronauts--the language of aerospace

BACKGROUND INFORMATION: Pilots, astronauts, control tower operators, and space capsule communicators use these words and phrases to make sure that their communications are brief and easily understood.

Primary Words and Phrases

Word or Phrase	Meaning
OVER	I expect a reply from you.
ROGER	I have received and understand your last message.
WILCO	I will do as you direct. I will comply.
OUT	My message is ended. No reply is expected.
NEGATIVE	No, or that is not correct.
SAY AGAIN	Repeat what you said.
CORRECTION	An error has been made. The correct words are . . . (give correct message).
SPEAK SLOWER	Speak slower.
STAND BY	Wait a few seconds, a delay is necessary.

Secondary Words and Phrases

Word or Phrase	Meaning
I SAY AGAIN	I will repeat what I said.
GO AHEAD	Go ahead with your message.
THAT IS CORRECT	Correct.
HOW DO YOU HEAR ME	Tell me how you hear me.

Parts of a Message

Each radio message has three parts.
Each part is as brief as possible.

1. The Call-Up:

   a. Identifies the caller and the receiver.
   b. Determines that both persons can hear each other.
   c. Sets the stage for communicating the message.

   The call-up includes the call sign of the station being called, the words THIS IS, the call sign of the caller, and word OVER.

   Example:

   Pilot: TULSA TOWER, THIS IS CESSNA AIT WUN FOW-ER WUN. OVER.
   Tower: CESSNA AIT WUN FOW-ER WUN, THIS IS TULSA TOWER. OVER.

2. The Message:

   a. Gives or requests information as clearly and briefly as possible.
   b. Allows the receiver to reply if necessary.

   Example:

   REQUEST LANDING INSTRUCTIONS. OVER.

3. The Ending:

   a. Acknowledges receipt of a message.
   b. Terminates radio contact.

   The ending includes the aircraft's call sign, the word ROGER, and if the contact is to end, the word OUT.

MATERIALS: International Phonetic Alphabet and Numbers

PROCEDURE:

1. Assign teacher a call sign, such as BAKER TOWER.

2. Assign each student a call sign, such as CESSNA WUN NIN-ER (roll number), followed by the initials of the student's first and last names.

(CESSNA WUN NIN-ER GOLF HOTEL would be the call sign of student number 19 on the roll, whose name is George Holt.) Have the students respond to roll call using the above procedures.

3. As students become more proficient in the use of aerospace words and phrases, role playing may progress to include origination, transmission, and reception of simulated aerospace messages that stimulate additional interest and generate new motivation. Messages might include:

    a. Pilot to Tower.
    b. Astronaut to Capsule Communicator.
    c. Tower to Pilot.
    d. Capsule Communicator to Astronaut.
    e. Pilot to another Pilot.
    f. Astronaut to another Astronaut.

TITLE:	Determining the Weather
CONCEPT:	Movement of air masses can be checked by referring to copies of the Daily Weather Map.
PURPOSE:	To familiarize students with the procedures used in predicting weather

MATERIALS: copies of the Daily Weather Map

PROCEDURE:

1. Distribute a copy of the Daily Weather Map, published by the U. S. Department of Commerce, to each group of four students.
2. Explain the charts, symbols and movement of air masses.
3. Each group will record the present weather using the station model for reference.
4. Determine the weather for the next 24-hour period from all available information.

NOTE: Charts and maps can be obtained from:
U. S. Department of Commerce
Environmental Science Services Administration
Environmental Data Service
Silver Springs, MD 20910

TITLE:	Rocket Launching
CONCEPT:	Specific information related to space and rocketry can be found in the encyclopedia.
PURPOSE:	To teach students to use an encyclopedia in order to learn about specific articles related to space and rocketry

MATERIALS:

paper
pencils
encyclopedia
list of subjects related to rocketry

PROCEDURE:

1. Give students a list of names and space topics such as:

Robert Goddard	Wernher von Braun
Thor-Delta	scout rocket
ballistic missile	trajectory
combustion	sounding rocket
gantry	lox
tracking stations	rocket
propellant	launch
supersonic	Redstone

2. Ask student to give name of reference book, page numbers where information begins and ends.

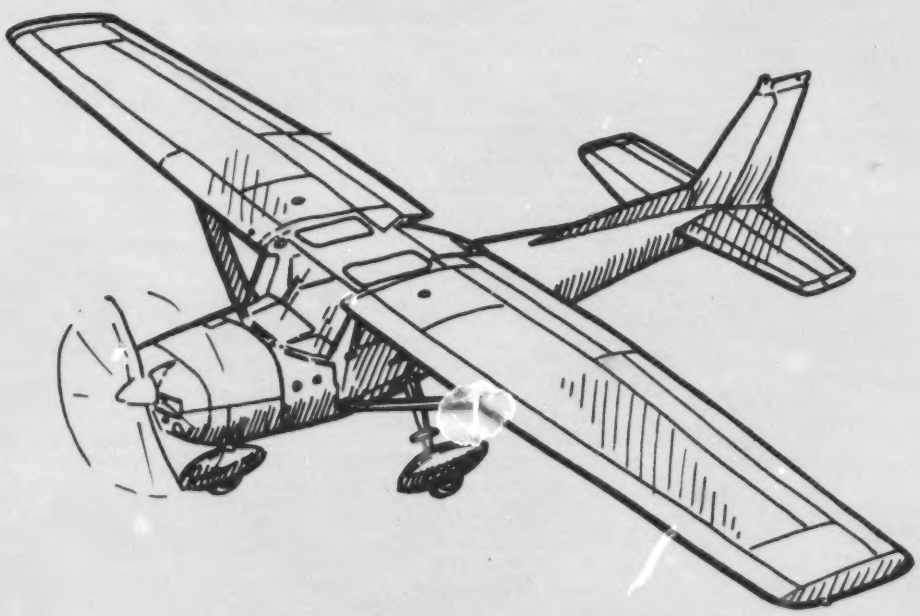
3. Discuss information the student learned about rocketry and persons associated with rocketry.

TITLE:	The Main Parts of an Airplane
CONCEPT:	An airplane is made up of different parts and each part has a different name.
PURPOSE:	The students will be able to identify the parts of an airplane

MATERIALS: study sheet, "The Main Parts of an Airplane," one per student
self-test sheet, "Parts of an Airplane," one per student

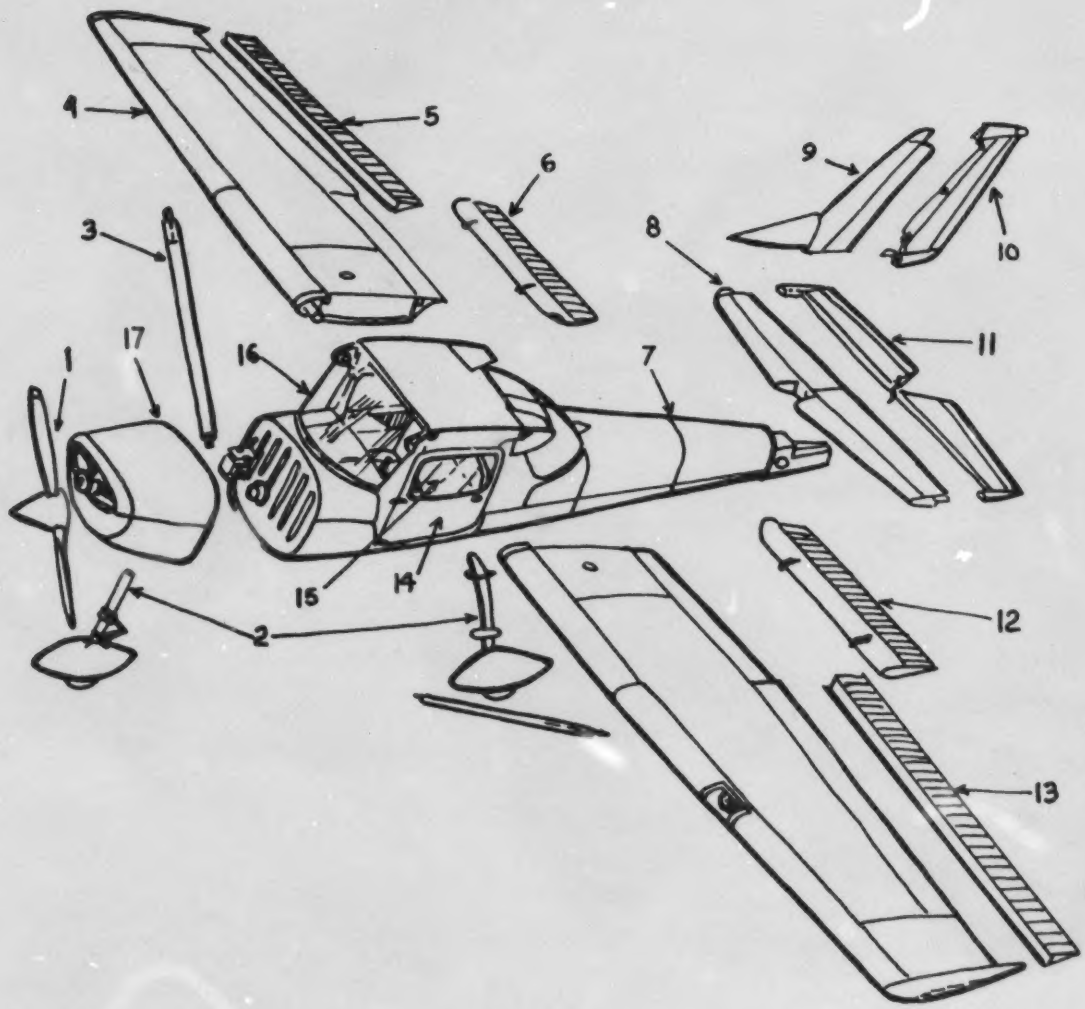
PROCEDURE:

1. Give study sheet to students.
2. Name and locate parts.
3. Follow with self-test sheet.
4. Encourage students to continue study of this sheet until all parts can be properly identified.
5. Variation for foreign language class: name the parts of the airplane in the appropriate foreign language.



THE MAIN PARTS OF AN AIRPLANE

1. Propeller
2. Landing Gear
3. Wing Strut
4. Wing
5. Right Wing Aileron
6. Right Wing Flap
7. Fuselage
8. Horizontal Stabilizer
9. Fin and Dorsal
10. Rudder
11. Elevator
12. Left Wing Flap
13. Left Wing Aileron
14. Door
15. Seat
16. Windshield
17. Engine Cowl

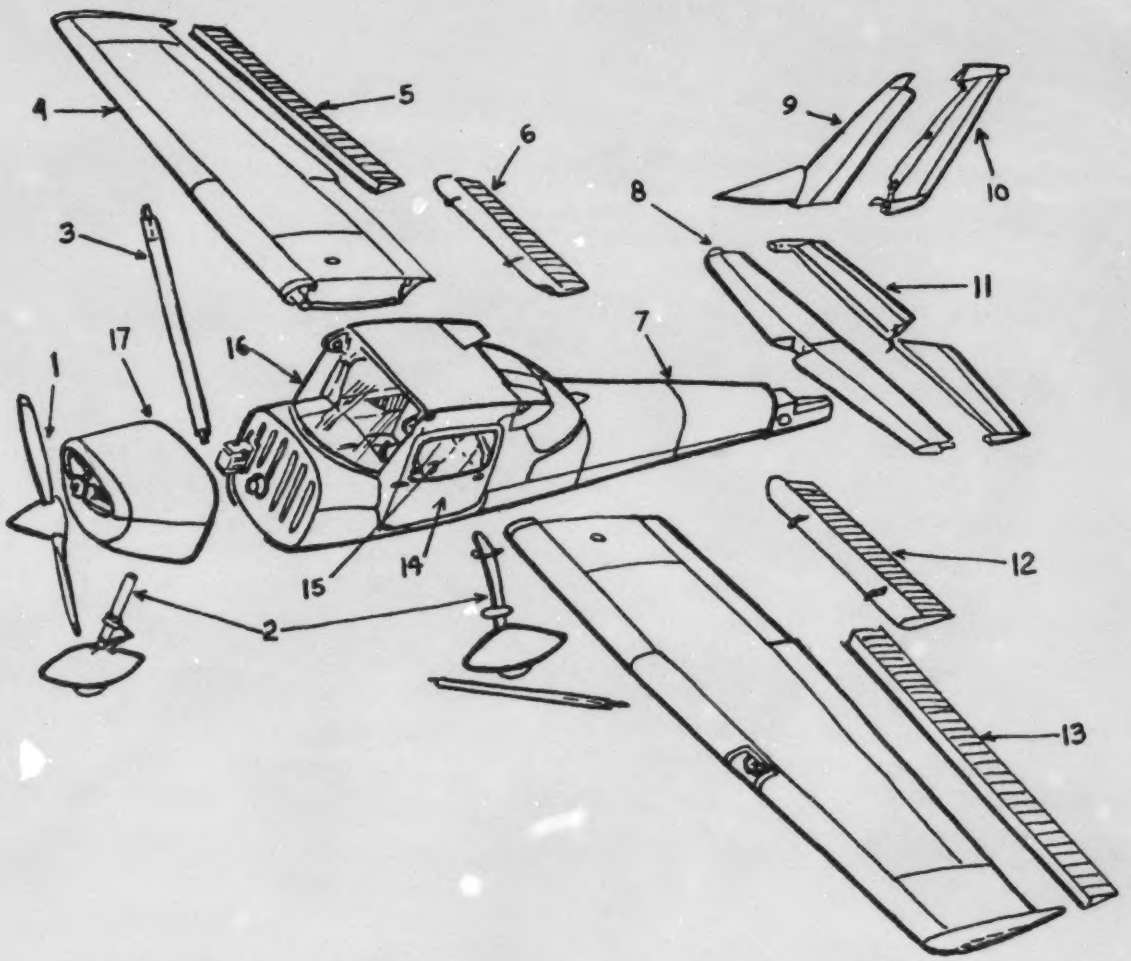


SELF-TEST

PARTS OF AN AIRPLANE

Write in the number of the part indicated in the photo in the blank preceding the listed part.

_____ rudder	_____ left flap	_____ right aileron
_____ wing strut	_____ engine cowl	_____ left aileron
_____ landing gear	_____ propeller	_____ elevator
_____ right flap	_____ spinner	_____ fuselage
_____ wing		



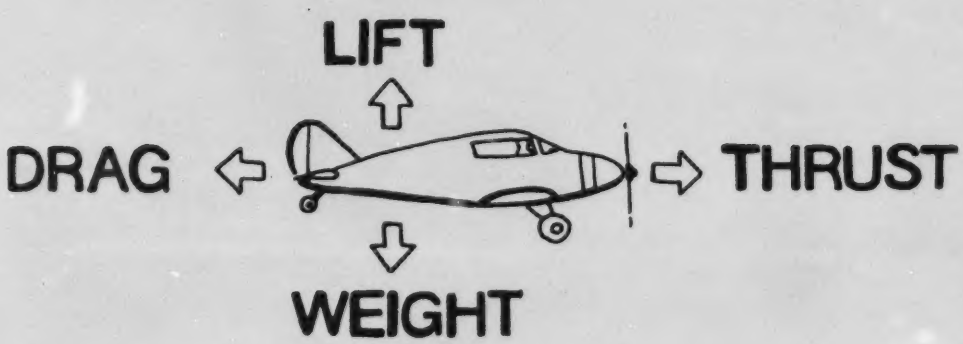
TITLE:	Principles of Flight
CONCEPT:	The four forces of flight are: thrust, drag, lift, and gravity.
PURPOSE:	Introduction of basic concepts pertaining to flight

MATERIALS: study sheets of the four forces of flight

PROCEDURE:

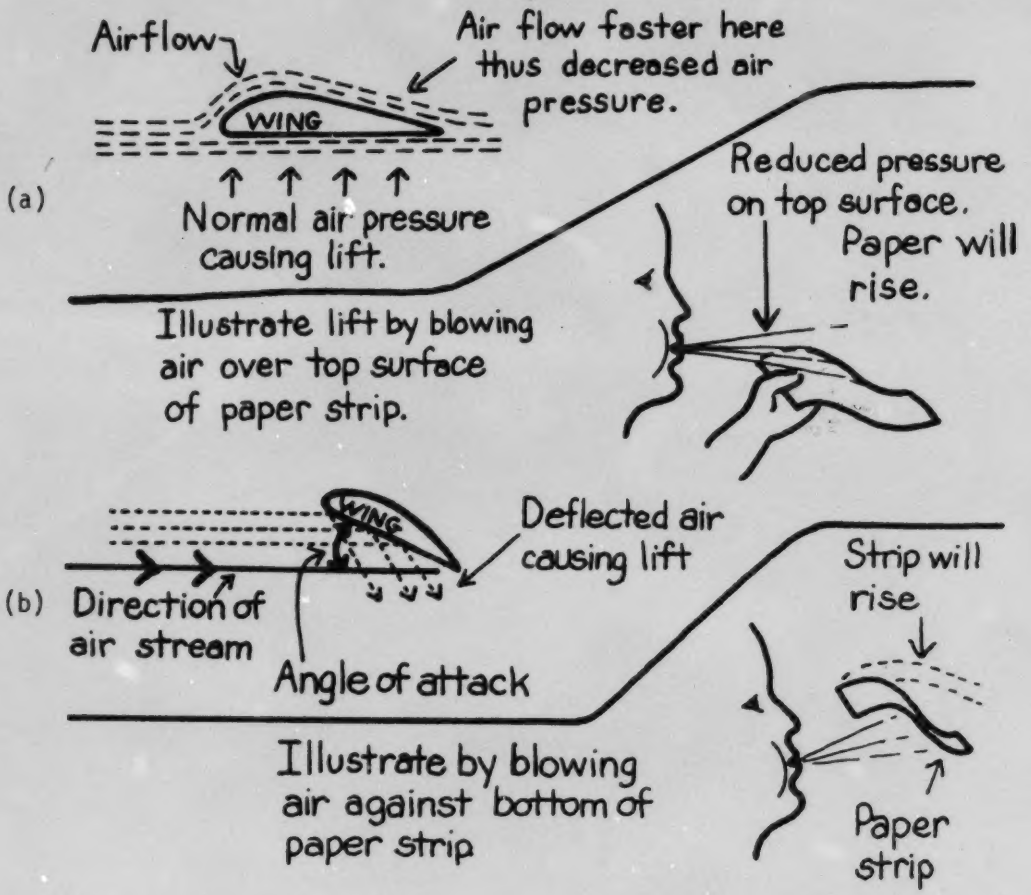
1. Give study sheets to each student.
2. Follow with discussion questions.
   a. What is lift?
   b. How could the lift on an aircraft be increased? (by increasing air speed and angle of attack)
   c. What causes drag? (structures of the airplane that will not let the air flow smoothly such as landing gear, wing struts, etc.)
   d. How can drag be reduced? (by streamlining the aircraft such as retractable landing gear, etc.)

FOUR FORCES



⇧LIFT

Lift is produced by (a) the difference in the speed of air flowing over the wing surfaces and (b) the angle of the wing to the air stream.



⇩WEIGHT

The weight of an aircraft is produced by the pull of gravity.

⇨THRUST

The forward force on an aircraft is produced by an engine-driven propeller, jet or rocket engine.

⇦DRAG

Resistance to the flow of air over the aircraft. Can be reduced by streamlining.

TITLE:	Wild and Crazy Models
CONCEPT:	The students can develop motor and mental skills by designing and constructing models of aircraft, rockets, and spacecraft.
PURPOSE:	To assemble model aircraft, rockets, and spacecraft from various materials

MATERIALS:

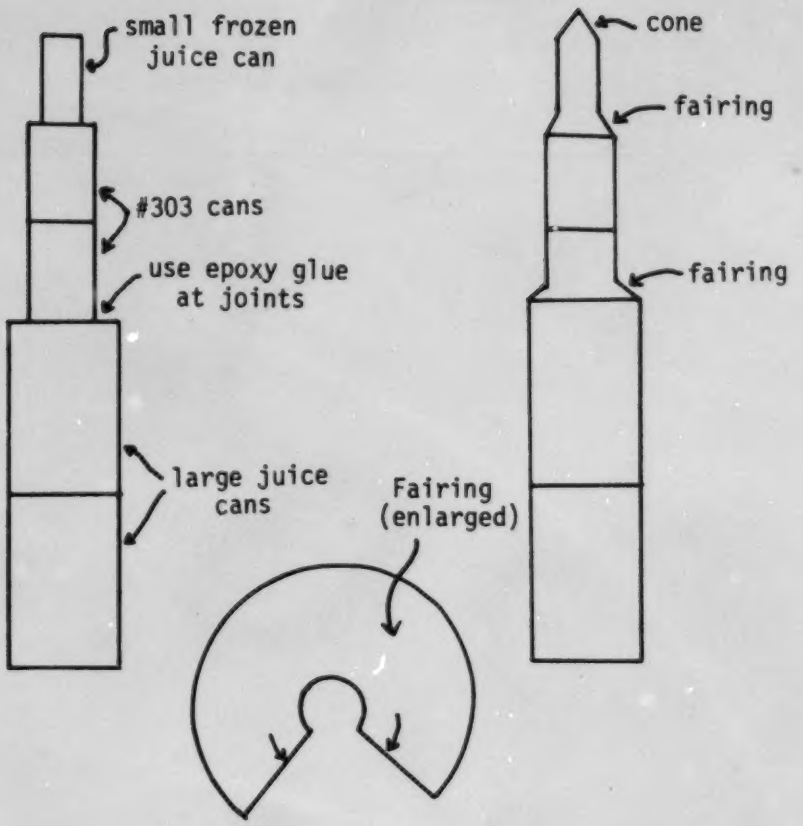
cans
plastic bottles
cardboard
paper
wood
wire
paper clips
paper cups
tape
glue

PROCEDURE:

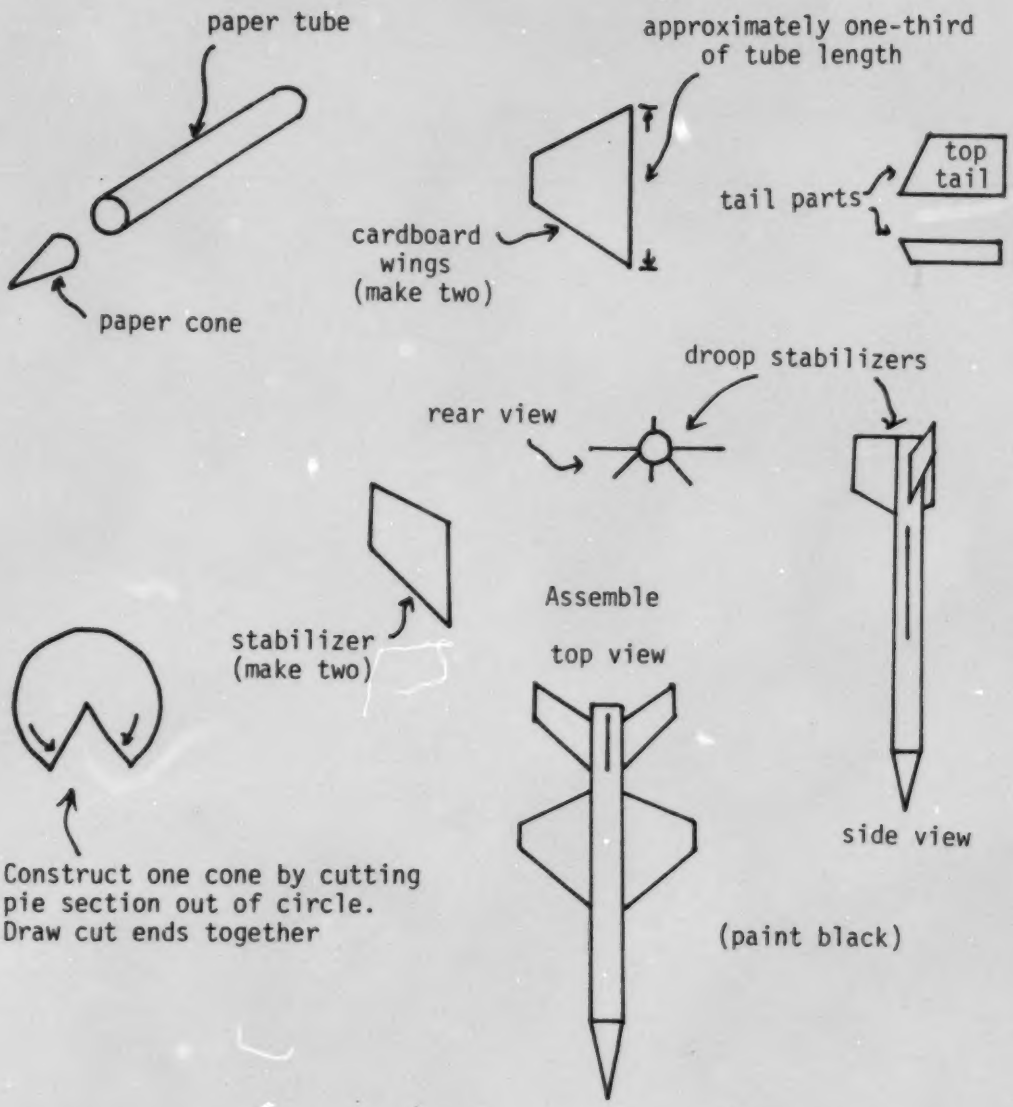
1. Using whatever scrounge materials are available, students will construct a model of an aircraft (i.e., hot-air balloon, blimp, dirigible, helicopter, rocket, or airplane).
   NOTE: The model need not be exact nor even resemble an existing aircraft.

2. A contest may serve as a rewarding completion of the activity. Judging criteria might include: originality, neatness, detail, original use of materials, etc.

SATURN V



Construct fairing from paper. Draw cut ends together to form cone. Experiment to find proper dimensions. Slip completed fairing over can assembly. Paint according to Saturn V color scheme.


paper tube
paper cone
approximately one-third
of tube length
cardboard
wings
(make two)
tail parts
top
tail
droop stabilizers
rear view
stabilizer
(make two)
Assemble
top view
side view
(paint black)
Construct one cone by cutting
pie section out of circle.
Draw cut ends together

TITLE:	Related Careers in Aerospace
CONCEPT:	The students will explore aerospace-related careers.
PURPOSE:	The students will have a greater understanding of the scope of aerospace careers.

BACKGROUND INFORMATION: The teacher will need to be informed to guide this activity. Salaries, years of training required, high school subjects needed for each career, etc., are some of the many facets that should be considered.

MATERIALS: All the materials needed are available in a business education classroom.

PROCEDURE:

1. Have a committee secure addresses of U.S. Air Force, N.A.S.A., Civil Air Patrol, Oklahoma Employment Agency, F.A.A., etc.
2. Each student will be graded on his/her typing and mailing of a request for career information from these agencies.
3. Compile addresses into categories such as military and non-military.
4. Design a bulletin board using aerospace careers as the theme.
5. The students will study the varied possible aerospace-related careers.

TITLE:	That Special Feeling
CONCEPT:	To fly is an exhilarating experience.
PURPOSE:	To have students imagine the experience of flying

BACKGROUND INFORMATION: Pilot Officer John Gillespie Magee, Jr., was an American citizen, born in Shanghai of missionary parents. After going to the United States in 1939, he won a scholarship to Yale at the age of 18. He, instead, enlisted in the Royal Canadian Air Force in September, 1940. He served with a Spitfire squadron of the R.C.A.F. until his death on December 11, 1941. The sonnet, "High Flight," was scribbled on the back of a letter to his mother in September, 1941, after he returned from a flight at 30,000 feet.

MATERIALS: copy of poem, "High Flight" for each student (or put on chalkboard or overhead projector)

PROCEDURE:

1. Have the students read the poem and then select one of the three following statements for response:

   a. Ask the question, "What does the poem mean and how do you feel about this?"
   b. Ask why Magee wrote the poem.
   c. Students who have flown may compare their feelings to those of the author.

3. Students will express their own feelings about flying in their creative writing.

"High Flight"

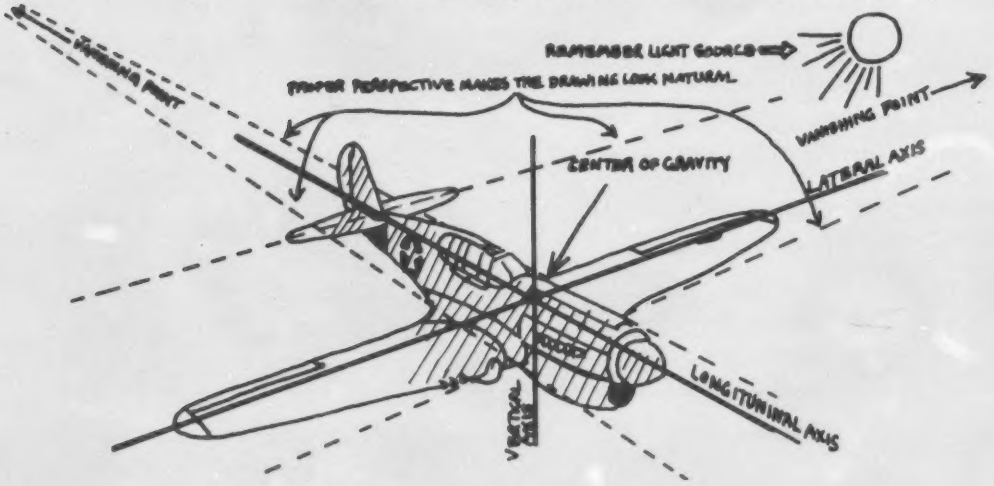
Oh! I have slipped the surly bond of earth
     And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth
     Of sun-split clouds - and done a hundred things
You have not dreamed of - wheeled and soared and swung
     High in sunlit silence. Hov'ring there
I've chased the shouting wind along, and flung
     My eager craft through footless halls of air.
Up, up the long, delirious, burning blue
     I've topped the wind-swept heights with easy grace
Where never lark, not even eagle flew--
     And, while with silent lifting mind I've trod
To high untrespassed sanctity of space
     Put out my hand and touched the face of God.

TITLE:	Sketching Aircraft
CONCEPT:	Two-point perspective drawing is an excellent method to use when sketching aircraft.
PURPOSE:	To introduce two-point perspective drawing of aircraft in order to achieve realistic sketches

MATERIALS:
pencil
paper
ruler
various drawing materials

PROCEDURE:

1. Determine the lateral axis, vertical axis, and longitudinal axis as illustrated. The center of gravity being the central point of these three axes.
2. Determine the vanishing points of the body section and the wing section as illustrated.
3. Build the aircraft around the center of gravity and the three axes of rotation when they are determined and lightly drawn.
4. Follow steps one through four of illustration for proper completion of the aircraft sketch.
5. Finish the drawing by shading the side away from the source of light. This adds a more realistic effect to the finished drawing.



TITLE:	Aerospace Art
CONCEPT:	We can learn about space through art activities.
PURPOSE:	To give the teacher various ideas for art activities centered around aerospace themes

MATERIALS: art and craft supplies

PROCEDURE: Have the students complete one or more of the following activities:

1. Draw or paint pictures of astronauts, space stations, a trip to the moon, space adventures, rockets, the phases of the moon, satellites, moonscapes, space vehicles, or planetary landscapes.
2. Design and build airplanes or airports out of blocks, cardboard tube rockets, gliders, child-sized spacecrafts, table model airports, rocket bases, space stations, or satellites.
3. Construct maps of the moon, paper bag space helmets, mobiles, and solar system models.
4. Paint murals of early aircraft, space flight, and lunar landings.
5. Construct collages of space pictures and terms.
6. Make models of space suits.
7. Draw or construct space shuttles. Use the Columbia as an example, if desired.
8. Pretend you have just discovered a new planet. Draw a picture of what you see.
9. Draw or paint a picture of what is on the other side of a black hole.
10. Draw space cartoons.
11. Make cardboard tube viewers. Place black paper over one end and use a pin to plot various constellations. Hold the viewer up toward a light to look at the constellations.

TITLE:	Our Solar System
CONCEPT:	Earth is one of nine planets revolving or orbiting about the sun.
PURPOSE:	To become familiar with the distance between the planets

BACKGROUND INFORMATION:

The earth is one of a family of nine planets revolving or orbiting about the sun. Nearest to the sun is Mercury, then Venus, then Earth. The paths traced by these planets are not circular, but oval or elliptical.

Because the sun is "off center," the distance between the sun and each planet changes every second, so we speak of distances between the sun and planets in terms of average distances.

MATERIALS:

paper
pencil

PROCEDURE:

1. The average distance between Earth and the sun is 92,912,000 miles, for Mercury it is 36,059,000 miles, and for Venus it is 67,206,000 miles.

   a. Express these average distances rounded off to the nearest million miles.
   b. The distances 92,912,000 miles, 36,059,000 miles, 67,206,000 miles have been rounded off to the nearest ___?___ miles.

2. Mars is Earth's outer neighbor in the solar system (sol is Latin for sun). The average distance between Mars and the sun is 141,568,700 miles. Uranus and Neptune are called twin planets. They are about the same size. Uranus orbits at an average distance of 1,782,227,700 miles from the sun, and Neptune at an average distance of 2,792,717,000 miles from the sun.

   a. Round off to the nearest hundred million miles, the average distances between the sun and: (1) Mars; (2) Uranus; (3) Neptune.

3. The two largest planets in our solar system are Jupiter, which orbits at a mean or average distance from the sun of 483,401,300 miles, and Saturn, at 886,270,100 miles. Pluto is our "way out" planet: 3,671,660,400 miles from the sun.

   a. Round off to the nearest ten million miles, the average distances between the sun and: (1) Jupiter; (2) Saturn; (3) Pluto.

TITLE:	Solar System Data
CONCEPT:	Planets vary in size.
PURPOSE:	To learn the relative size of the planets

BACKGROUND INFORMATION: In the table below are given the diameters of the nine planets. The zeros in these numerals indicate that they have been rounded off to different places.

Planet	Diameter (in miles)
Mercury	3,012
Venus	7,584
Earth	7,927
Mars	4,220
Jupiter	86,800
Saturn	75,100
Uranus	30,900
Neptune	33,000
Pluto	3,700

MATERIALS:
pencil
paper

PROCEDURE:

1. Have students make a table showing the nine planets of the solar system, arranged according to diameters, from the least to the greatest.

2. From the tables of the solar system data, decide whether the following statements are true or false.

   a. Pluto is the smallest planet. (F)
   b. Uranus orbits at an average distance from the sun that is about twice the average distance from the sun as its neighbor, Saturn. (T)
   c. Earth orbits in a path that is nearer to the sun than Mars, but farther from the sun than Venus. (T)
   d. The nearer a planet is to the sun, the warmer it is, so Earth must be a warmer planet than Jupiter. (T)

TITLE:	The Universe
CONCEPT:	The students will be able to define the terms: (1) solar system, (2) galaxy, (3) universe.
PURPOSE:	To introduce the students to the concept of the Universe

MATERIALS:

1--12 inch styrofoam ball
2--6 inch styrofoam balls
2--4 inch styrofoam balls
3--2 inch styrofoam balls
2--1 inch styrofoam balls
poster paints
brushes
white glue
string
map and hat pins
book with pictures and descriptions of the planets

PROCEDURE:

1. Put the following vocabulary words on either the chalkboard or overhead projector:

Mercury	Saturn	Solar system
Venus	Uranus	galaxy
Earth	Neptune	universe
Mars	Pluto	stars
Jupiter		

2. Write the sentence that stands for the order and name of the planets. My Very Excellent Mother Just Served Us Nine Pies.

3. Write the names of the planets beginning with the one nearest the Sun and in order out to the farthest away from the Sun. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

4. Define the terms: (1) solar system, (2) galaxy, (3) universe.

5. Form nine groups of students and assign each group a planet. Each group should learn:

   a. The color of their planet.
   b. Any special features.
   c. How many moons it has.

6. Hand out the styrofoam ball for each group:

12 inch for the Sun . . . yellow with black or brown dots
1 inch for Mercury . . . reddish
2 inch for Venus . . . blue with cotton for clouds
2 inch for Earth . . . blue with cotton clouds and brown continents
6 inch for Jupiter . . . banded with red spot
6 inch for Saturn . . . orange with rings cut from paper
4 inch for Uranus . . . bluish green
4 inch for Neptune . . . greenish blue
2 inch for Mars . . . reddish brown with dark markings
1 inch for Pluto . . . who knows?

Paint them and hang them in order in the classroom from strings. Add pins for moons.

NOTE: To make a mobile, balance the planets in pairs on wooden dowels.

TITLE:	The Size of the Sun
CONCEPT:	The apparent size of objects is dependent on their real size and their distance from the observer.
PURPOSE:	To understand the relationship of the sun, earth, and moon during an eclipse

BACKGROUND INFORMATION: An eclipse occurs when either the earth blocks the light of the sun from the moon or the moon blocks the light of the sun from the earth. The moon is about 2,000 miles in diameter while the diameter of the sun is about 865,000 miles.

MATERIALS:
1--1 gallon jar
1--½ pint jar
large beach ball or basketball
marble

PROCEDURE:

1. Place the gallon jar in view of your room, about 200 feet from the school building.
2. Hold the ½-pint jar in front of the class and point out the jar outside. Ask the question, which jar do you think is the larger of the two?
3. Have one of the students retrieve the gallon jar and then discuss the comparative size of the two jars.
4. Using the large ball and marble, relate the sizes of the spheres to the sun and the moon.
5. Have a pupil A hold the marble between two fingers and at arm's length. Have a pupil B stand about 5' from pupil A and hold the large ball at eye level.
6. Pupil B should move to the proper distance from pupil A to have the marble just block off the large ball. This is an eclipse.
7. Have pupil A move the marble closer to and farther from his eye. Discuss the effect of this movement on the eclipse.

TITLE:	Planets in Orbit - Part I
CONCEPT:	Planets revolve around the sun at different speeds and at different distances.
PURPOSE:	To better understand that the sun's gravity keeps the planets in orbit

BACKGROUND INFORMATION: Each planet moves around the sun at different speeds and at different distances. The greater the planet's distance from the sun, the slower it moves.

Mercury, Venus, Earth and Mars are sometimes referred to as the inner planets. Below is a chart giving the number of Earth days it takes for each of the inner planets to make one complete trip around the sun.

Mercury	88 Earth days
Venus	225 Earth days
Earth	365 Earth days
Mars	687 Earth days

MATERIALS:
paper
pencil

PROCEDURE:

1. Put above chart on chalkboard or overhead projector.

2. Have students answer the following questions:

   a. How many more Earth days does it take Earth to complete its orbit than
      (1) Venus? (140)
      (2) Mercury? (277)
   b. What is the difference in Earth days between the orbits of
      (1) Mercury and Venus? (137)
      (2) Venus and Mars? (462)
   c. The orbit or Mars takes how many Earth years and days? (1 year, 322 days)
   d. If we think of a year as the time it takes for a planet to make one complete orbit, one Earth year would be equal to about how many Mercury years? (4+ Mercury years)

e. Is a Mars year longer or shorter than an Earth year? (longer)
f. Which planet comes closest to having a year that is half that of a Mars year? (Earth)
g. How many more Earth days would have to be added to Mercury's orbit to equal a Mars year? (599)

TITLE:	Planets in Orbit - Part II
CONCEPT:	Planets revolve around the sun at different speeds and at different distances.
PURPOSE:	To better understand that the sun's gravity keeps the planets in orbit

BACKGROUND INFORMATION:

Jupiter, Saturn, Uranus, Neptune and Pluto are sometimes referred to as the outer planets of our solar system. The orbits of these planets are billions of miles greater than that of Earth, and so their "year" is much greater than Earth's.

The time it takes each of the outer planets to make one complete trip around the sun, rounded off to the nearest complete Earth year, is given below:

Jupiter	12 Earth years
Saturn	30 Earth years
Uranus	84 Earth years
Neptune	165 Earth years
Pluto	248 Earth years

MATERIALS:

pencil
paper

PROCEDURE:

Put above chart on chalkboard or overhead projector. Have students answer the following questions:

1. How many Earth years would have to be added to Uranus' orbit to have it equal to Neptune's? (81)

2. Pluto's orbit is greater than Neptune's by how many Earth years? (83)

3. Among the outer planets, two have "years" that are about 2½ times that of neighboring planets. Which pair of planets are they? (Saturn, Uranus)

4. Which outer planet has an orbit that is about one and a half times as long as its nearest planet neighbor? (Pluto)

TITLE:	Planets in Orbit--Part III
CONCEPT:	Planets revolve around the sun at different speeds and at different distances.
PURPOSE:	To better understand that the sun's gravity keeps the planets in orbit

BACKGROUND INFORMATION: The motion of the planets in the solar system is something like a giant merry-go-round with nine "animals" to ride. Only on this merry-go-round, each "animal" travels at a different speed around the center.

At times the planets will be side by side on the same side of the sun, as in the drawing above; at other times they will be "across the sun" from each other. In the following table are listed the planets and the times between two successive "line-ups" with the sun and Earth, on the same side of the sun.

Mercury	116 Earth days
Venus	584 Earth days
Mars	760 Earth days
Jupiter	399 Earth days
Saturn	378 Earth days
Uranus	370 Earth days
Neptune	367 Earth days
Pluto	367 Earth days

The period of time it takes for a planet to "line-up" with Earth on the same side of the sun is called its synodic period.

MATERIALS: paper
pencil

PROCEDURE: Put above chart on chalkboard or overhead projector. Have students answer the following questions:

1. Mars has a synodic period that is how many days longer than that of Venus? (196)

2. How many times will Mercury in its orbit "lap" Earth in the course of a year? (3)

3. Is the sum of the synodic periods of Venus and Saturn greater than the sum of the synodic periods of Mercury, Jupiter and Neptune? If so, by how many days? (Yes; 80 days)

4. The sum of synodic periods of two planets in our solar system is 119 days more than the sum of synodic periods of two other planets. Which planets are they? (Jupiter and Saturn)

TITLE:	Low Residue Meals for Astronauts
CONCEPT:	The astronauts consume basically low residue meals during their space flights.
PURPOSE:	The students will gain experience in planning low residue meals

MATERIALS: film "Living in Space--Part 2: Regenerative Processes," NASA Headquarters 131 B-1967

PROCEDURE:

1. Show NASA film, "Living in Space," color, 20 min.
2. Provide and discuss sample low residue meals for astronauts and their importance in the space program.
3. Have each student plan a nutritious menu for one day. Select only those foods which are low residue and will give a balanced diet.

SAMPLE MENUS FOR ASTRONAUTS

	First Day	Second Day
Meal 1:	Apricot Nectar	Prune Bits
	Grapenuts	Scrambled Eggs
	Bread Wafers III	Bread Wafers I
	Mocha Beverage	Milk
	Coffee	Coffee
Meal 2:	Fruit Cocktail	Cream Soup
	Shrimp Casserole	Tomato Aspic
	Bread Wafers I	Cheese Sandwiches
	Lemon Gelatin	Rice Pudding
	Jordan Almonds	Honey Squares
	Coffee	Coffee
Meal 3:	Beef Salad	Blended Juices
	Bread Wafers II	Beef and Gravy
	Applesauce	Mashed Potatoes
	Space Squares	Peas
	Milk	Pecan Bites
	Coffee	Tea
Meal 4:	Pineapple Juice	Vegetable Soup
	Breast of Chicken	Ham Patties
	Mashed Potatoes	Bread Wafers II
	Glazed Carrots	Banana Milk Shake
	Cornmeal Wafers	Nougats
	Strawberry Dessert Bites	
	Tea	

TITLE:	Aerospace Word Search
CONCEPT:	Aerospace terminology can become a part of the students' expressive and receptive vocabulary.
PURPOSE:	Learning aerospace vocabulary can be reinforced by use of word search fun sheets.

MATERIALS: word search sheet
pencil

PROCEDURE:

1. Distribute copy of word search activity sheet to each student.
2. Instructions for completion of the activity are on the word search sheet.

WORD SEARCH

The constellations are hidden in the puzzle. They may appear forward, backward, up, down, or diagonally in the puzzle. Can you find all of the words listed below?

Andromeda
Aquarius
Aquila
Aries
Bootes
Capricornus
Centaurus
Corona Borealis
Draco
Gemini
Hercules
Virgo
Leo
Lepus
Libra
Ophiuchus
Orion
Pisces
Sagittarius
Scorpius
Taurus
Ursa Major
Ursa Minor

A C B O I A S C E N T A U R U S T E S M
M R L R D S Q W U R S A M I N O R S I A
T H I P G A J U O H C T E B T G S N J N
O J B E Q L P J I J A S M S M I T A E X
P O R J S U A L Q L O F M L F M H E P B
H P A K Q M J U T K A K B W E W D N C O
I Q U L A U E A R D I G S G S O L W G S
U S U S P T R O E S R N H J T F P R L M
C W R P D A V M N E M A Q K D T I S O A
H U C E L U O R I O N U C I W V W G D S
U R E J P R Q B S S U N R O C I R D A C
S D O A D U W U K B O T F L C B S I S M
O B D N G S I G C E H C W K T I T S L G
H O A B L P S N H E R C U L E S E C W A
M O E R R W F C T R N R F E P W J E L T
O T I O L J N S A G I T T A R I U S H S
F E C S D T O H U A O B A H K P A W D U
I S T N C U K Q J O C I R U J T O G A P
R J H N H G B A Q U A R I U S E H I W E
C O R O N A B O R E A L I S F S L W S L

WORD SEARCH

1) aerodynamics
2) aileron
3) air
4) airplane
5) airway
6) altimeter
7) altitude
8) ascend
9) aviation
10) bank
11) barometer
12) ceiling
13) chart
14) cirrus
15) compass
16) contact
17) course
18) current
19) degree
20) dive

21) drift
22) elevation
23) engine
24) fin
25) flaps
26) flight
27) gear
28) glide
29) horizon
30) instruments
31) knot
32) land
33) lift
34) pilot
35) radar
36) ramp
37) stall
38) tail
39) thrust
40) turn
41) wind
42) wing
43) zoom

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AEROSPACE WORD SEARCH

W E A T H E R A B A R O M E T E R N E T
A I R P L A N E E Q N X F P Z H J R N K
L Q E C G J A E R O S P A C E S E V G F
T W D R A G L D I V E A I X C H N V I L
I O U Y D M E T U H C A R A P T G U N I
M Y T I M L A E L T T U H S R G I B E G
E R I E U G N B D M L A O C O N N K R H
T X T S I O C H O F G M B I P M E P B T
E D L V O F L I G H T F N E E R G E D T
R O A L J A N A S A R I P N L S T A L L
S N L I S C W S F L A P S C L A U N C H
O A T S U R H T N L G R S E A D R C E E
B E E C H I M R O C K E T P N Q R P S A
R K Q T I B R O R S A S R B T A I L S C
A A L A N U B N D E F E A I R P L A N E
D W N X Y S P A C E Z A C R S T M N A O
A J K U L U V U W H I R K C O M P A S S
R J D E L I F T F R S C I G N I T I O N
I N S T R U M E N T S H N T O P F I N Q
L O C K H E E D K L M D G R A V I T Y E

astronaut
rocket
propellant
NASA
space
shuttle
navigation
flight
launch
altitude
dive

aerospace
research
tracking
parachute
science
ignition
lunar
orbit
lift
drag
thrust

gravity
atmosphere
air
airplane
altimeter
engine
balloon
Lockheed
Beech
Cessna
weather

instruments
barometer
flight
compass
stall
radar
degree
fin
flaps
tail

TITLE:	Isometrics and Physical Fitness
CONCEPT:	Isometric exercises are a good method of maintaining physical fitness in a confined area.
PURPOSE:	To become aware of the type of exercise performed by astronauts during space flights

BACKGROUND INFORMATION: Due to limited area in the space cabin, activities to maintain physical fitness must be designed for these accomodations.

MATERIALS: watch with second hand or stop watch

PROCEDURE:

1. Grasp right hand in left hand and pull in opposite directions while hands are held together for 5 seconds, 10 seconds, and 20 seconds.
2. Grasp left leg at the knee with clasped hands. Pull leg toward chest 12 times. Repeat procedure with right leg.
3. Clasp hands behind head. Pull in opposite directions.
4. In a seated position, clasp hands under legs. Pull in opposite directions.

TITLE:	Physical Fitness and Exercise
CONCEPT:	Limited area exercise is a good method of maintaining physical fitness in a confined area.
PURPOSE:	To become aware of the type of exercises performed by astronauts during space flights

BACKGROUND INFORMATION: Due to limited area in the space cabin, the activities to maintain physical fitness must be designed for these accommodations.

MATERIALS:
bicycle inner tube, 20"
piece of broom handle, 8" long
watch with a second hand or a stop watch

PROCEDURE:

1. Loop-hitch the bicycle inner tube around the middle of the wooden handle and tighten securely.
2. Count the pulse for a period of 30 seconds and record.
3. Place one foot in the open end of the loop while holding the handle with both hands.
4. Pull the loop against the foot, release, continuing this operation at the rate of one pull per 30 seconds. Change immediately to the other foot and repeat the operation.
5. At the end of the second operation, check the pulse again. Note the change in pulse rate and muscular feeling.
6. See illustration of exercise positions below.

TITLE:	Human Reaction Time
CONCEPT:	Space flight requires the ability to respond quickly to various stimuli such as lights, sound (verbal or instrumental), etc.
PURPOSE:	Relate reaction time to the rapid responses required during space flights

BACKGROUND INFORMATION: Astronauts are ever aware of the possible occurrence of unusual situations during spaceflight. Unexpected problems may arise on a long space flight calling for rapid responses using the senses of light, sound, and feeling. The faster the reaction time of an astronaut and the crew, the better chance they will have in coping with situations.

MATERIALS:
reaction time card
stop watch (or watch with second hand)
pencil

PROCEDURE:

1. Two students should work together, one to test his reaction time while the other student times his responses.

2. Touch each square in the block in numerical order. Record the time.

Over 9 seconds	slow
9 seconds	about average
7 seconds	very good
5 seconds	excellent

HUMAN REACTION TIME

Time ____ seconds

5	7	1	2
9	8	11	6
12	10	3	4

Time ____ seconds

Time ____ seconds

5	12	3	10
7	11	6	1
2	4	9	8

Time ____ seconds

Time ____ seconds

4	2	10	12
9	3	8	5
11	7	6	1

Time ____ seconds

TITLE:	Lost on the Moon
CONCEPT:	Survival in space depends upon equipment available.
PURPOSE:	To determine by group consensus the rank importance of survival items

BACKGROUND INFORMATION: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. However, due to mechanical difficulties, your ship was forced to land at a spot some 200 miles from the rendezvous point. During the moon landing, much of the equipment aboard was damaged, and since survival depends upon reaching the mother ship, the most critical items available must be chosen for the 200-mile trip.

MATERIALS:
copy of "Lost on the Moon Survival Items" for each student
pencil

PROCEDURE:

1. Divide class into workable groups (5 - 6 students per group).

2. Explain that this is an exercise in group decision making. Each group is to use the method of group concensus in reaching its decision. This means that the prediction for each of the 15 survival items must be agreed upon by each group member before it becomes a part of the group decision. Concensus is difficult to reach, therefore, not every ranking will meet with everyone's approval. Try, as a group, to make each ranking one with which all group members can at least partially agree.
   NOTE: This should be done as individual decision first, <u>then</u> group activity.

3. Allow 15 minutes for group decisions.

4. Post-lab. Review each item, check group decisions, compile data, then compare to NASA ranking (see Key to "Lost on the Moon").

"LOST ON THE MOON SURVIVAL ITEMS"

Error points - absolute difference between your ranks and NASA's (no + or -)

0 - 25	excellent - the FORCE is with you!
26 - 32	good
33 - 45	average
46 - 55	fair
56 - 70	poor
71 - 112	very poor - Did you fake it or just use earth-bound logic?

ITEMS	YOUR OWN RANKING	Error Points	YOUR GROUP RANKING	Error Points
Box of matches	___	___	___	___
Food Concentrate	___	___	___	___
Fifty feet of nylon rope	___	___	___	___
Parachute silk	___	___	___	___
Solar-powered portable heating unit	___	___	___	___
Two 45-caliber pistols	___	___	___	___
One case of Pet milk	___	___	___	___
Stellar map (of the moon's constellation)	___	___	___	___
Two 100-pound tanks of oxygen	___	___	___	___
Self-inflating life raft	___	___	___	___
Magnetic compass	___	___	___	___
Five gallons of water	___	___	___	___
Signal flares	___	___	___	___
First aid kit containing injection needles	___	___	___	___
Solar-powered FM receiver/transmitter	___	___	___	___
TOTALS	___	___	___	___

KEY TO "LOST ON THE MOON"

Your spaceship has just crash-landed on the dark side of the moon. You were scheduled to rendezvous with your mother ship 200 miles away on the lighted surface of the moon, but the rough landing has ruined your ship and destroyed all the equipment on board, except for the 15 items listed below.

Your crew's survival depends on reaching the mother ship, so you must choose the most critical items available for the 200-mile trip. Your task is to rank the 15 items in terms of their importance for your survival.

NASA'S RANKING	NASA'S REASONS
15	No oxygen to sustain the flame
4	Good food energy source, efficient
6	Useful in scaling cliffs, tying together the injured
8	Will provide protection from sun's rays
13	Useless on dark side, not needed on lighted side
11	Possible means of propulsion
12	Bulky duplication of food concentrate
3	Primary means of navigation
1	Most pressing need
9	CO_2 Bottle in raft may be used for propulsion
14	Magnetic field on moon is not polarized, worthless
2	Replacement for high water loss on light side
10	Distress signal when mother ship sighted
7	For injecting vitamins - special aperture in suit
5	Talk to mother ship, FM needs short range and line of sight

TITLE:	Weather Satellites
CONCEPT:	Weather satellites have greatly improved our methods of weather forecasting.
PURPOSE:	To learn the effects of weather satellites as applied to agriculture, and also, to appreciate the vastly improved system of weather forecasting and how it helps farmers

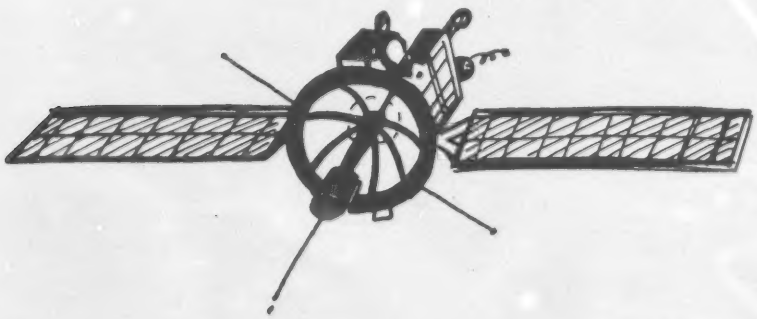
MATERIALS:

NASA pamphlets or booklets such as:
- For the Benefit of All Mankind
- Putting Satellites to Work
- Space Benefits, Today and Tomorrow

NASA films such as:
- Space Down to Earth
- Meteorology From Space

PROCEDURE:

1. Preview films and read the written materials.
2. Ask questions about weather satellites:
   a. What do you know about them?
   b. How are they useful to farmers?
   c. What are three advantages of weather satellites?
3. Have students watch weather reports.
4. Discuss weather reports.



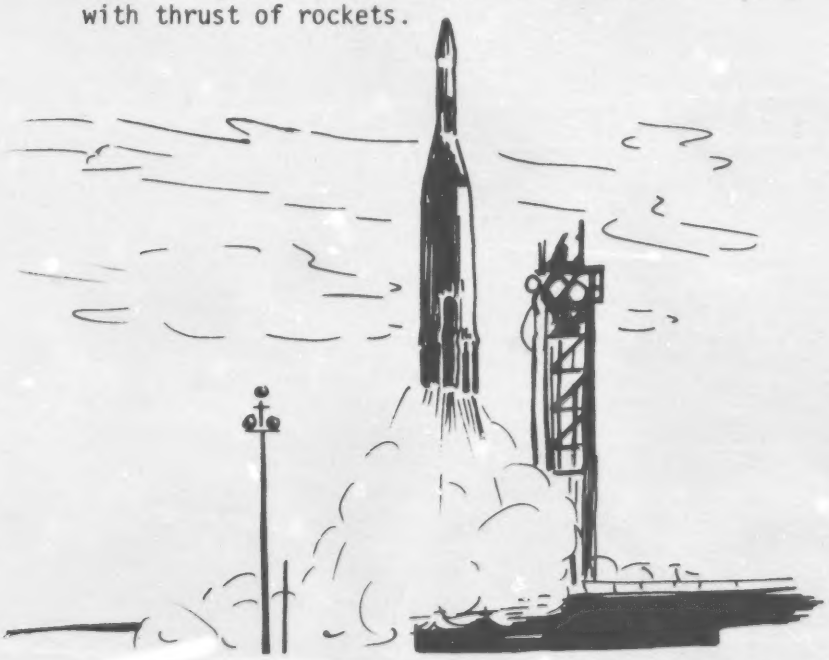
TITLE:	Who is the Winner?
CONCEPT:	Newton's Law--For every action there is a reaction.
PURPOSE:	Students will observe that the force which propels the balloon (thrust) is similar to force used to move rockets.

MATERIALS:
balloons, one for each student, if possible
toy cars
tape
string
glue

PROCEDURE:

1. Attach a balloon (loosely tied or glued) to small object that has wheels (toy cars, etc.).
2. Have the students take turns blowing up the balloon and releasing the air.
3. Have individual races or team races and award prizes to winners.

FOLLOW-UP:
Discuss how the action (released air) caused a reaction (thrust) that moved the vehicle. Compare with thrust of rockets.



TITLE:	Finding Plane Routes
CONCEPT:	The shortest distance between two points is a straight line.
PURPOSE:	The students will identify the route which is most likely to be used when flying from one city to another

BACKGROUND INFORMATION: Establish that the shortest distance between two points is a straight line. Using a globe and a string, show that a straight line on Earth is part of a great circle. Explain that whenever possible, planes follow a great circle.

MATERIALS:
globes
maps
string
rulers
pencils
activity sheets

PROCEDURE:

1. Duplicate the activity sheets so that students will have one.

2. Using the materials necessary, the students will do the activities on the activity sheets.

FINDING PLANE ROUTES
ACTIVITY SHEET

1. Use a globe showing the major cities of the world. Measure the distance between Tokyo and Los Angeles with a string and lay the string on a ruler to see how long the string is between the two cities. Measure again to see if there is a shorter way to go. What distance did you measure?_____ Is there a shorter way you could fly from one to the other?_____If the answer is "yes," explain._____
While flying from Tokyo to Los Angeles, you cross the _____ Ocean. You leave the continent of _____ and fly to the continent of _____.
2. Using the map, draw the route to fly from Seattle to Washington. A city which might be added to the route without lengthening it greatly, would be the city of_____.
Plot the best air route on the map between these cities: Dallas, St. Louis, New Orleans, Salt Lake City, Boston, and San Francisco. Leaving from Minneapolis and returning to Minneapolis, plot the plane route to these cities: Houston, Phoenix, New York, Tulsa, and Denver. This flight would take place in the country of _____. This flight would be on the continent of_____. Would it be closer to fly from Los Angeles to Atlanta to Washington, or to fly from Los Angeles to St. Louis to Washington?_____Pretend you

are going to fly around the world. You have a limited budget and will need to be conservative in your use of fuel. List the cities you plan to visit in the spaces below. Also indicate any oceans you cross. Oklahoma City, _____, _____,

_____, _____, _____,

_____, _____, _____.

List the continents you visited. _____,

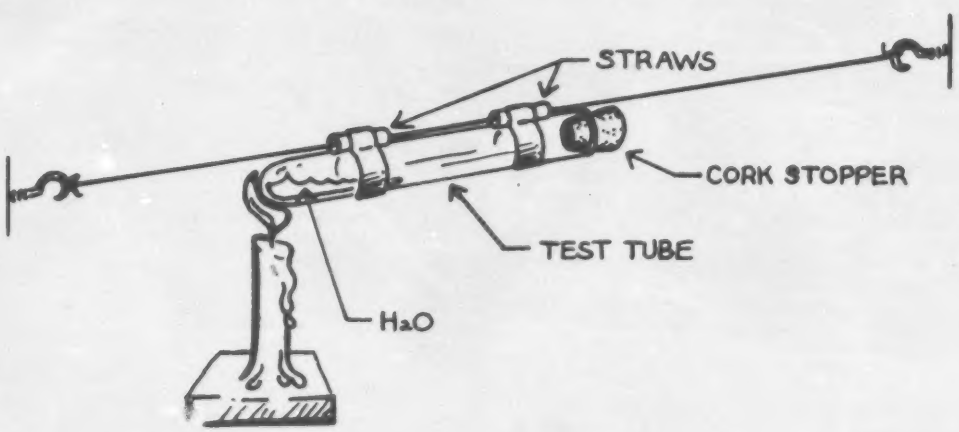
_____, _____, _____.

TITLE:	Construction of Action-Reaction Engines
CONCEPT:	The rocket's basic operation is based on Newton's Third Law of Motion: "For every action there is an equal and opposite reaction."
PURPOSE:	To discover similarity between this experiment and the propulsion system used on a rocket engine

MATERIALS:
small test tube with cork (Pyrex test tube from science lab)
water
candle
thread
ring stand
Vaseline

PROCEDURE:

1. Set up apparatus as illustrated.



2. Lubricate cork stopper with Vaseline.

3. Place a tablespoon of water in the bottle. Position test tube over candle flame and note the reaction of the test tube as the cork pops out.

4. Answer the following questions:
   a. How does this investigation illustrate Newton's Third Law?
   b. Discuss the similarity between this propulsion system and a rocket engine.

TITLE:	My Space Flight
CONCEPT:	The idea of being alone in space brings forth mixed feelings and emotions.
PURPOSE:	Students will gain appreciation of the vastness of space

BACKGROUND INFORMATION:

In the strict poetic sense, Cinquain poetry (pronounced San(d)cane) has five lines with a certain number of syllables per line: 2, 4, 6, 8, 2.

Haiku is a three-line verse form which originated in thirteenth century Japan. Characteristics of authentic Haiku: three lines--line one contains five syllables; line two contains seven syllables; line three contains five syllables--seventeen in all. Each poem includes the season, location, and reference to nature. The subject matter deals with simple, ordinary things. Japanese words usually end in vowels or "n" sounds. Remember that the thought comes first, then the syllables are adjusted to fit the form.

MATERIALS:

pictures or slides of the planet Earth and other planets
pencils
paper
other writing material as needed

PROCEDURE:

1. Project or display the image of the planet or planets.
2. Write your reactions or feelings about being alone in space.
3. Try using the following:
   a. Cinquain
   b. essays
   c. free verse
   d. Haiku

4. The following example might be helpful:

1._____

2._____ _____

3._____ _____ _____

4._____ _____ _____ _____

5._____

a. Use one word to name the subject you are writing about on line #1.

b. Use two words to describe #1.

c. Use three words to describe what #1 is doing.

d. Use four words to tell how you feel about #1.

e. Use a word that means the same as #1.

TITLE:	Space Firsts
CONCEPT:	Research can enable students to become aware of important space firsts.
PURPOSE:	To identify persons and events significant in the development of space flight

MATERIALS: various research materials

PROCEDURE:

1. Research the events listed below.
2. Identify the person or spacecraft described, and the month and year the event took place.

The first (spacecraft or person) . . .	Date
_____ (1) . . . liquid-fuel rocket.	_____
_____ (2) . . . man-made satellite.	_____
_____ (3) . . . American satellite.	_____
_____ (4) . . . weather satellite.	_____
_____ (5) . . . man in space.	_____
_____ (6) . . . American in space.	_____
_____ (7) . . . American manned-space project.	_____
_____ (8) . . . American to orbit the Earth.	_____
_____ (9) . . . interplanetary space probe.	_____
_____ (10). . . planet visit by a probe.	_____
_____ (11). . . woman in space.	_____
_____ (12). . . American to walk in space.	_____
_____ (13). . . American unmanned lunar landing.	_____
_____ (14). . . manned lunar landing.	_____
_____ (15). . . men on the moon.	_____
_____ (16). . . U.S. orbiting workshop.	_____
_____ (17). . . Martian soft landing by an American spacecraft.	_____

Answer Key: The statement number is in parenthesis followed by answers. The statements are in chronological order.

(1) Robert Goddard . . . . . Mar., 1926

(2) Sputnik I (USSR) . . . . . Oct., 1957

(3) Explorer I . . . . . Jan., 1958

(4) Tiros-I . . . . . Apr., 1960

(5) Yuri Gagarin (USSR) . . . . . Apr., 1961

(6) Alan B. Shepard . . . . . May , 1961

(7) Mercury 1961-1963

(8) John Glenn (Mercury) . . . . . Feb., 1962

(9) Mariner II (launch) . . . . . Aug., 1962

(10) Venus (Mariner II) . . . . . Dec., 1962

(11) Valentina Tereshkova (USSR) . . . Jun., 1963

(12) Edward H. White III (Gemini 4) . . Jun., 1965

(13) Surveyer . . . . . May , 1966

(14) Apollo 11 . . . . . Jul., 1969

(15) Armstrong and Aldrin . . . . . Jul., 1969

(16) Skylab 1973-1974

(17) Viking . . . . . Jul., 1976

TITLE:	Flight Vocabulary (Quiz)
CONCEPT:	Students will increase their overall knowledge of flight procedures by using aeronautical terms properly.
PURPOSE:	To check progress after studying aeronautical terminology

MATERIALS: copy of Vocabulary Quiz for each student
pencil

PROCEDURE:
1. Distribute copy of Vocabulary Quiz as study sheet.
2. After discussion of terminology, administer quiz.

(KEY)

1. H	9. J	17. T
2. L	10. K	18. M
3. G	11. P	19. F
4. O	12. U	20. B
5. Q	13. V	21. N
6. I	14. C	22. A
7. D	15. S	
8. R	16. E	

VOCABULARY QUIZ

1. ___ Apogee
2. ___ Command guidance
3. ___ Igniter
4. ___ Mach
5. ___ Control surface
6. ___ Gas generator
7. ___ Mass ratio
8. ___ Captive test
9. ___ Inertial guidance
10. ___ Engine, vernier
11. ___ Inhibitor
12. ___ Hypersonic
13. ___ Nozzle
14. ___ Perigee
15. ___ Yaw
16. ___ Roll
17. ___ Ballistic missile
18. ___ Re-entry
19. ___ Sustainer engine
20. ___ Pitch
21. ___ Drag
22 ___ Regressive burning

A. That combustion characteristic of a solid propellant rocket which results in greater thrust at first

B. Rotational movement around the lateral axis of the craft

C. The point in an earth satellite's orbit at which it is closest to the earth

D. The ratio between mass of a fully-fueled vehicle at takeoff and the final mass of the vehicle and payload

E. Rotational movement of an aircraft about a longitudinal axis

F. An upper-stage engine which continues to deliver thrust after the main rocket engines have been burned up or discarded

G. A device or chemical which causes propellants to begin combustion

H. The point in the orbit of an earth satellite where it is farthest from the earth

I. A combustion chamber that generates gases to drive turbines or to provide limited thrust for attitude control

J. A self-contained guidance system in which controls are pre-set before take-off

K. A small rocket engine used to obtain a fine adjustment in the speed or path of a ballistic missile

L. A guidance system where directions are given to a missile or craft from an outside source such as in radio guidance

M. The returning through the earth's atmosphere and generally to the earth's surface

N. Force opposite to that of flight

O. Speed equal to the speed of sound

P. A substance to restrict the burning surface of a solid propellant and to give direction to the burning process

Q. A moveable surface such as the aileron on a winged aircraft that is used to control the motion

R. The test of a rocket engine or motor when it remains stationary as distinguished from a flight test

S. Rotation of an aircraft about its vertical axis

T. A missile guided at launch but thereafter its path is affected only by its momentum, gravity, and air drag

U. Speed greater than five times the speed of sound or faster than Mach 5

V. The exhaust duct of a rocket combustion chamber in which gases are accelerated to higher velocities

TITLE:	Scientific Notation
CONCEPT:	Exponents are used in science, by calculators, and by computers to shorten the writing of large numbers.
PURPOSE:	To learn to express a number as the product of a number between one and ten and a power of ten

PROCEDURE:

1. Express each number in the second column without using an exponent.
2. Express each number in the third column in scientific notation.

Examples: The distance from the earth to the moon is about 240,000 miles.

$240{,}000 = 2.4 \times 10^5$

The distance from the earth to the sun is about 93,000,000 miles.

$93{,}000{,}000 = 9.3 \times 10^7$

Planet	Diameter (km)	From the sun (km)
Mercury	5.0×10^3	57,900,000
Venus	1.218×10^4	108,230,000
Earth	1.276×10^4	149,590,000
Mars	6.76×10^3	227,720,000
Jupiter	1.427×10^5	778,120,000
Saturn	1.21×10^5	1,428,300,000
Uranus	4.67×10^4	2,872,700,000
Neptune	4.95×10^4	4,498,100,000
Pluto	6.4×10^3	5,914,300,000

(answers on next page)

ANSWERS:			
	Mercury	5,000	5.79×10^7
	Venus	12,180	1.0823×10^8
	Earth	12,760	1.4959×10^8
	Mars	6,760	2.2772×10^8
	Jupiter	142,700	7.7812×10^8
	Saturn	121,000	1.4283×10^9
	Uranus	46,700	2.8727×10^9
	Neptune	49,500	4.4981×10^9
	Pluto	6,400	5.9143×10^9

TITLE:	A Conversation on the Principles of Jet Aviation in the French Language
CONCEPT:	Practice will enable students to express their thoughts in a foreign language.
PURPOSE:	Students will gain experience conversing in French

MATERIALS:

activity sheets in French (one for each student)
set of definitions of pertinent vocabulary
current French periodical, such as Paris Match
Cessna teaching aids (Cessna has a plant in Theims, France; their brochures in French are available. Write to: Cessna Teaching Aids
Air Age Education Department
P. O. Box 1521
Wichita, KS 67201

PROCEDURE:

1. Duplicate activity sheets on the following page(s) for each student.
2. Practice reading the conversation.
3. Locate parts of the airplane on the sketch.

Activity Sheet--Principles of Jet Aviation

PROCEDURE:

1. The teacher should read a basic guide to aviation in English or French. (Cessna has an excellent and simple guide.)
2. A set of printed definitions should be given to each student. After the teacher has presented the first definition, simple questions should be asked in order for students to participate. Do not correct grammar errors at this stage. Your purpose is to get a conversation started. Allow students to make mistakes in order to make conversation for a few minutes. When a degree of confidence has been achieved, the polishing of grammar and idioms can begin.
3. After all the vocabulary has been introduced, start pattern drills. Flight principles will allow the teacher a vehicle to review the following:

   a. Le Subjonctif

   b. Prendre + temps + infinitif
   Combien de temps est-ce-que ça prend pour aller à Paris en avion?

   Le cargo prendrait des semaines pour y aller.

   Une construction alternative avec il faut + temps + pour + infinitif
   Combien de temps faut-il pour aller à Paris en avion?

   c. Pour aller quelque part, on prend l'avion. Le verbe prendre indique le moyen de transport que vous utilisez. Si vous dites votre destination, il faut employer un verbe de mouvement.

   Ne dites surtout pas: «J'ai pris l'avion à Paris». Non, non! Cela veut dire que vous êtes monté dans l'avion à Paris!

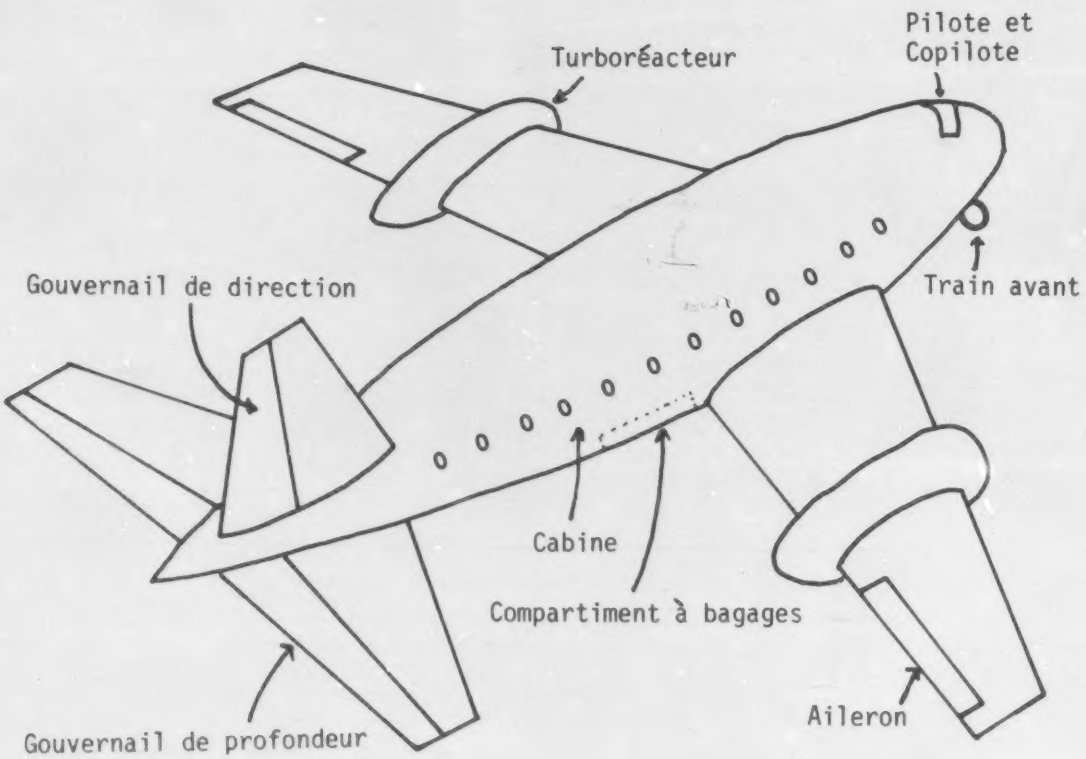
   Si vous voulez dire que vous êtes allé à Paris par avion, vous employez le verbe «aller».

* * * * * * *

La Caravelle

PROCEDURE: The teacher will introduce the basic vocabulary on the operational parts of the Caravelle. No English should be used. A coupling of new information on an interesting subject with the study of a foreign language will give the student a feeling of self-achievement and of confidence. When the learner becomes more interested in what he/she wishes to say than how he/she is to say it, he/she finds him/herself eager to master language skills.

Cet avion est un moyen-courrier prévu pour des etapes de 2000 à 3000 km. Longueur-32m. Envergure-34m. Capacite des réservoirs-18 500 litres de kérosène. Poids au décollage-43 tonnes. Charge payante-9 tonnes de marchandises. 64 passagers de ler classe ou 80 de class «touriste» . Propulsion 2 turboreacteurs Rolls Royce «Avon» de 4 800 kg de poussee. Vitesse de croisière-825 km/h.


Turboréacteur
Pilote et
Copilote
Gouvernail de direction
Train avant
Cabine
Compartiment à bagages
Aileron
Gouvernail de profondeur

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TITLE:	Say Again
CONCEPT:	Role playing is an excellent method of teaching conversational foreign language.
PURPOSE:	To learn the vocabulary necessary for communication between the airline hostess and passengers in Spain, France, Italy, or other foreign countries.

MATERIALS: foreign language books and resource materials from airline companies (available from American, Braniff, etc.)

PROCEDURE:

1. Write conversations between hostess and passengers.
2. Translate into foreign language.
3. Use these conversations in classroom with students taking turns being hostess, pilot, passenger, etc.

TITLE:	On Target
CONCEPT:	Learning about space can be fun.
PURPOSE:	Students will become familiar with aerospace terminology.

MATERIALS:
encyclopedia
paper
pencil
word list for each student

PROCEDURE:

1. Students should locate and study the main entry on space in the encyclopedia.
2. Distribute scrambled word list.
3. Have students unscramble the words on the list.

SCRAMBLED WORD LIST

1. CEPSA	6. BRTOI	11. TSUAANTRO
2. YLXAAG	7. ICERUSPSNO	12. ARATFRIC
3. NAPSRTTRO	8. HTIFGL	13. BYKSAL
4. LPATEN	9. NELRPAAI	14. TLFI
5. CREYUMR	10. TRIAOPR	15. NWRYUA

SCRAMBLED WORD LIST (KEY)

1. space	6. orbit	11. astronaut
2. galaxy	7. supersonic	12. aircraft
3. transport	8. flight	13. Skylab
4. planet	9. airplane	14. lift
5. Mercury	10. airport	15. runway

TITLE:	Space Shuttle for Down-to-Earth Benefits
CONCEPT:	There are many benefits to be gained by utilizing spin-off know-how from our space program.
PURPOSE:	To make the students aware of some of the benefits to be derived on earth from some of our space missions

BACKGROUND INFORMATION: Since 1958, when the United States launched its first satellite, the 30-pound Explorer I, the nation has learned to use space as a tool for the benefit of mankind on Earth.

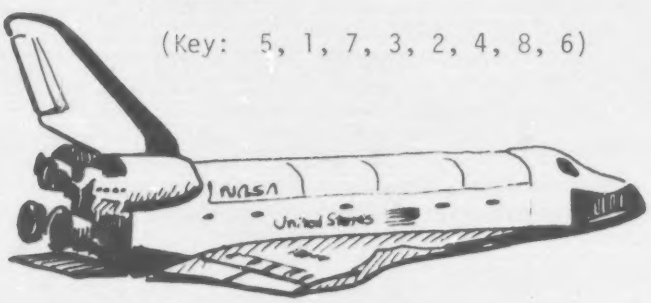
Space is being used today in connection with weather forecasting, storm tracking, locating and managing earth resources, long-range communications, and a variety of scientific studies. As these uses of space were developing, we mapped, explored, and studied the moon; mapped much of Mars; sent probes to Venus and Saturn; and determined that man can live and work in space.

The Space Shuttle - a manned space transportation system - is designed to reduce the cost and increase the effectiveness of using space for commercial, scientific, and defense needs. It will benefit the entire nation.

MATERIALS: copy of matching test
pencil

PROCEDURE: Identify a few of the many space shuttle benefits by matching the paragraph on the left to the appropriate label.

(Key: 5, 1, 7, 3, 2, 4, 8, 6)



SPACE SHUTTLE BENEFITS

1. Communications satellites have made intercontinental television possible and are reducing the costs of transocean telephone calls. The costs will decrease again when the reusable Shuttle takes new and improved satellites into earth orbit.

2. Photos of the earth taken from space have led to discoveries of oil and natural gas on three continents. The improved satellites emplaced by Space Shuttle can locate new sources of fossil fuels.

3. A copper deposit estimated to be worth $10 billion was discovered in northern Nevada as a result of Skylab pictures. The advanced satellites emplaced by Shuttle are expected to make many other valuable mineral discoveries.

4. A pollution-mapping satellite can cover the entire continental United States in about 500 photographs; cameras carried in high-altitude airplanes would need about 500,000. It is possible to monitor from space in a few days what would take years by air.

5. Sensor systems in space can help the world solve its food problems. The sensors can identify crops in each field, tell the vigor of the crops, the probable yield, the identity of plant diseases or insect infestation, and provide vital inventories of food for mankind.

6. Shuttle-launched satellites can help conserve our forest resources by discovering fires, by detecting tree diseases and infestations of pests, and by providing accurate inventories of our timber lands.

_____Agriculture

_____Communications

_____Fishing Industry

_____Mineral Resources

_____Petroleum Resources

_____Pollution

_____Scientific Studies

_____Timber

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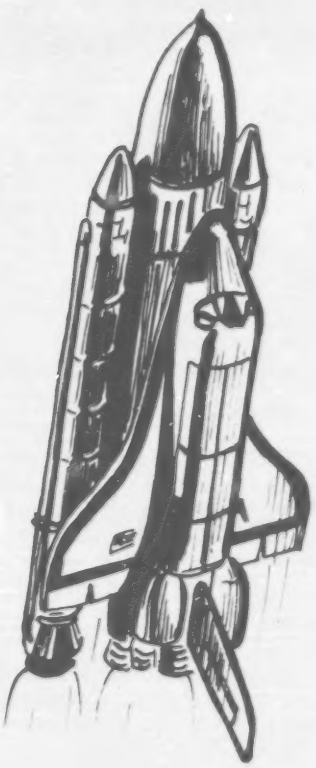
7. By mapping the ocean surface temperature, earth resources satellites will help oceanographers understand current patterns. This, in turn, will enable fishing experts to predict the movements of schools of fish.

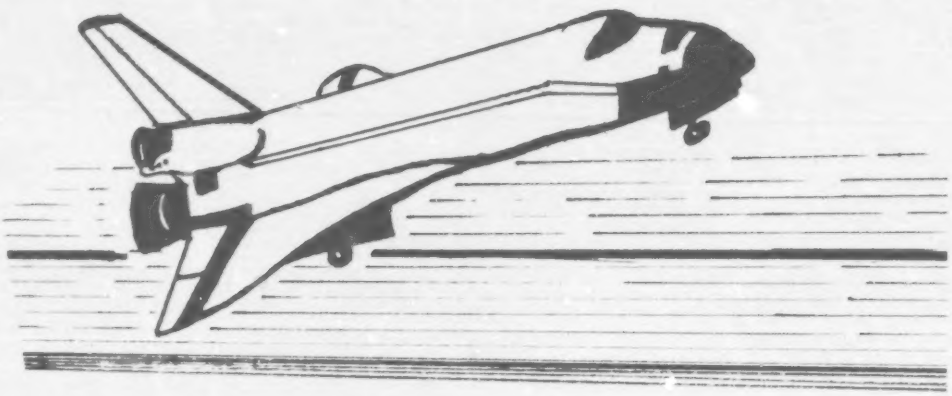
8. Shuttle is capable of taking into earth orbit completely equipped scientific laboratories and as many as six passengers. In the weightless environment of space, scientists can perform many tasks that cannot be accomplished against earth's gravitational pull.



APPENDIX

CLEARED

FOR LANDING



GLOSSARY

ablation:	the vaporization of an outer covering (as of a spacecraft) to keep the inner part cool
abort:	to cut short (an action or operation of an aircraft, guided missile, etc.), as because of some failure in the equipment
aerobatics:	performance of stunts in an airplane or glider
aerodynamics:	the science that treats the motion of air and other gaseous fluids, and of the forces acting on bodies when the bodies move through such fluids, or when such fluids move against or around the bodies
aeronautics:	the science, art, or work of designing, making, and operating aircraft
aerospace:	the earth's atmosphere and the space beyond
aileron:	a movable hinged section in or near the trailing edge of an airplane wing for controlling the rolling movements of the airplane
aircraft:	a weight-carrying machine for navigation of the air that is supported either by its own buoyancy or by the action of the air against its surface
airfoil:	a part with a flat or curved surface, as a wing, rudder, etc., designed to keep an aircraft up or control its movements by reacting in certain specific ways to the air through which it moves
airship:	any self-propelled aircraft that is lighter than air and can be steered; dirigible

airspeed:	the speed of an aircraft relative to the air through which it moves rather than to the ground
altimeter:	an instrument for indicating the relative altitude of an airplane by measuring atmospheric pressure
altitude:	height; esp., the height of a thing above the earth's surface
animometer:	a device for measuring the velocity of the wind, in common use at airports
apogee:	the point farthest from the earth in the orbit of the moon or of a man-made satellite
Apollo:	United States program with the objective of earth-orbiting a space laboratory, launching astronauts to the vicinity of the moon, and landing a man on the moon, then returning him to earth
astro:	a prefix meaning "star" or "stars" and, by extension, sometimes used as the equivalent of "celestial," as in astronautics
azimuth:	the initial angle or direction between true North and a great circle course
balloon:	an airtight bag filled with heated air or with a gas lighter than air so as to rise and float above the ground
bank:	to incline an airplane laterally when turning
barometric pressure:	the pressure of the atmosphere as indicated by a barometer
beacon:	a signal light or radio transmitter emitting signals for guidance of airplanes
Bernoulli's principle:	as the speed of a confined fluid increases, the fluid pressure decreases

bioastronautics:	aeronautics considered for its effect upon animal or plant life
biplane:	an airplane with two main supporting surfaces usually placed one above the other
blimp:	a small balloon-shaped airship
boosters:	the first stage of a multi stage rocket providing thrust for the launching and the initial part of the flight
camber:	to curve upward in the middle
capsule:	a small pressurized compartment for an aviator or astronaut for flight or emergency escape
ceiling:	the greatest height at which an airplane can maintain level flight or operate efficiently
Celsius:	centigrade
center of gravity:	the point through which the resultant forces of gravity acts no matter how the body is oriented
centrifugal force:	the force that tends to impel a thing or parts of a thing outward from a center
cockpit:	a space in the fuselage of an airplane for the pilot or the pilot and passengers or in a large passenger plane the pilots crew
constellation:	any of 88 groups of stars forming patterns (as the Big Dipper) or an area of the heavens covering one of these groups
contact:	direct visual observation of the earth's surface made from an airplane esp. as an aid to navigation
drag:	the retarding force acting on a body (as an airplane) moving through a fluid (as air) parallel and opposite to the direction of motion

elevator:	a movable airfoil usually attached to the tail plane of an airplane for producing motion up or down
empenage:	the tail assembly of an airplane
escape velocity:	the minimum velocity that a moving body (as a rocket) must have to escape from the gravitational field of the earth or of a celestial body and move outward into space
exosphere:	the outer fringe region of the atmosphere
FAA:	Federal Aeronautics Administration
Fahrenheit:	relating or conforming to a thermometric scale on which under standard atmospheric pressure the boiling point of water is at 212 degrees above the zero of the scale and the freezing point is at 32 degrees above zero
flight line:	a parking and servicing area for airplanes
flight path:	the path of the center of gravity of an airplane in flight
flight plan:	specified information relating to the intended flight of an aircraft that is filed orally or in writing with an air traffic control facility
front (weather):	the boundary between two different air masses
fuselage:	the main structure or central section of an airplane which houses or contains the crew, passengers, cargo, etc.
glide:	sustained forward flight in which speed is maintained only by the loss of altitude
glider:	a heavier-than-air aircraft, the free-flight of which does not depend upon a power-generating unit
gravity:	the force of attraction between two bodies; the force that makes a body, if free to move, accelerate toward the center of the earth

ground speed:	the speed of the aircraft relative to the ground
ground visibility:	prevailing horizontal visibility near the earth's surface as reported by the National Weather Service or an accredited observer
haze:	fine dust or salt particles scattered through a portion of the atmosphere
heading:	the direction in which the nose of the airplane points during flight
helicopter:	a type of rotorcraft, the support of which, in the air, is normally derived from airfoils mechanically rotated about an approximately vertical axis
humidity:	the measure of water vapor content in the air
hypoxia:	oxygen deficiency in blood cells or tissue
inertia:	the tendency of a body to remain as it is, either at rest or in motion, until acted upon by some outside force
lift:	the force on an airfoil, perpendicular to the relative wind, exerted normally upward, opposing the pull of gravity
monoplane:	an airplane having one lifting surface
orbit:	to send up and make revolve in an orbit (orbit a satellite)
ozonosphere:	an atmospheric layer at heights of approximately 20 to 30 miles characterized by high ozone content
pitch:	the blade angle of a propeller
reentry:	the action of reentering the earth's atmosphere after travel in space
runway:	a strip, either paved or improved, on which takeoffs and landings are effected

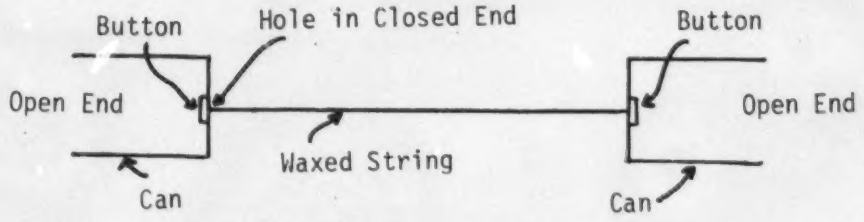
satellite:	a man-made object or vehicle intended to orbit the earth, the moon, or another celestial body
solar system:	the sun and the planets, asteroids, comets and meteors that revolve around it
sonic boom:	a noise caused by a shock wave that emanates from an aircraft or other object traveling at or above the speed of sound
sounding balloon:	a free, unmanned balloon instrumented and/or observed for obtaining a sounding of the atmosphere
spin:	a prolonged stall in which an airplane rotates about its center of gravity while it descends
spiral:	a prolonged gliding or climbing turn during which at least 360^{0} change of direction is effected
stability:	the tendency of an airplane in flight to remain in straight, level, upright flight
stabilizer:	the fixed airfoil of an airplane used to increase stability
stall:	the flight maneuver or condition in which the air passes over and under the wings stops providing lift to hold the aircrafts attitude
standard temperature lapse rate:	a temperature decrease of approximately 2^{0} Celsius for each 1,000 feet increase in altitude
statute mile:	5,280 feet or 0.867 nautical miles
supercharger:	a pump or compressor for forcing more air or fuel-air mixture into an internal combustion, reciprocating engine than it would normally induct at the prevailing density altitude

supercooled water:	water that has been cooled below the freezing point but still is in a liquid state
thrust:	the forward force on an airplane in the air, provided by the engine
torque:	any turning, or twisting force
track:	the flight path made good over the ground by an aircraft
traffic pattern:	the traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport
true altitude:	the altitude above mean sea level
turbulence:	irregular motion of the atmosphere produced when air flows over a comparatively uneven surface
variation:	the angle difference at a given point between true north and magnetic north
vertigo:	sensory confusion, usually associated with dizziness and inability to tell which way is up
visibility:	in weather observing practice, the greatest distance in a given direction at which it is possible to see and identify with the unaided eye
visual flight rules(VFR):	when weather conditions are above the minimums prescribed for visual meteorological conditions pilots may fly with visual reference to the ground
wake turbulence:	the turbulence caused by a moving aircraft
wind sock:	a cloth sleeve, mounted aloft at an airport to use for estimating wind direction and velocity

wind tee:	an indicator of wind direction for take-off and landing
wing:	an airfoil whose major function is to provide lift
wing flap:	a movable section of an airfoil used to change the effect of air flow over the airfoil
yaw:	to turn about the vertical axis
Zulu time:	Universal time; local civil time in Greenwich, England, and is used throughout the world in navigation

TEACHING AIDS

Airport Model:	Include runways, wind tee, and control tower. Construct with paper, cardboard, cloth, or other readily available materials.
Model Aircraft:	Construct with note paper.
Model Spacecraft Center:	Construct with note paper, cardboard, or other available materials.
Globe:	Available in classroom or school library. Use desk lamp to cast shadows, show day and night, and visualize spacecraft orbits.
Bulletin Board:	Display charts showing International Phonetic Alphabet and pronunciation of numbers, words, and phrases used in radio/telephone communications.
Classroom Exhibits:	Use models, pictures, or cutouts of aircraft, space vehicles, tracking stations, control towers, or other air or space equipment.
Student Workbook:	Available in quantity for use in teaching International Phonetic Alphabet and Numbers as well as aerospace words and phrases used in communicating. Write to National Headquarters, Civil Air Patrol, Maxwell Air Force Base, AL 36112, for free copies.
Communications Trainers (Basic):	Construct using two tin cans, waxed string, and buttons, as follows:



Communications Trainers (Tube):	Use long paper tubes, such as mailing containers. Glue together short sections to provide desired length.
Communications Trainers (Electronic):	Use modified tape recorders, walkie-talkies, or other electronic communications equipment.

TIME LINE OF LUNAR PROBES

DIRECTIONS: Given the following table of dates for launches of the various lunar probes, construct a time line identifying each of the probes.

HINTS: You might have 2cm = 1 month. You might, also, identify the U.S.A. launches in one color and the U.S.S.R. launches in another color.

Name	Country	Launch Date	Vehicle	Remarks
Thor-Able 1 (Pioneer)	U.S.A.[a]	Aug. 17, 1958	Thor-Able	1st attempt to probe Moon: failed.
Pioneer 1	U.S.A.	Oct. 11, 1958	Thor-Able	Failed to reach Moon; sent 43 hrs. of data.
Pioneer 2	U.S.A.	Nov. 8, 1958	Thor-Able	Failed to reach Moon.
Pioneer 3	U.S.A	Dec. 6, 1958	Juno II	Failed to reach Moon; provided radiation data.
Luna 1	U.S.S.R.	Jan. 2, 1959	A-1	Passed within 6,000 km of the Moon; went into solar orbit.
Pioneer 4	U.S.A.	Mar. 3, 1959	Juno II	Passed within 60,000 km of the Moon; went into solar orbit.
Luna 2	U.S.S.R.	Sept. 12, 1959	A-1	1st probe to impact on Moon.
Luna 3	U.S.S.R.	Oct. 4, 1959	A-1	1st probe to photograph Moon's far side.
Atlas-Able 4 (Pioneer (P-3))	U.S.A.	Nov. 26, 1959	Atlas-Able	Failed to reach Moon.
Atlas-Able 5A (Pioneer (P-30))	U.S.A.	Sept. 25, 1960	Atlas-Able	Failed to reach Moon.
Atlas-Able 5B (Pioneer (P-3))	U.S.A.	Dec. 15, 1960	Atlas-Able	Failed to reach Moon.
Ranger 3	U.S.A.	Jan. 26, 1962	Atlas-Agena B	Missed Moon by 36,800 km; ended in solar orbit.
Ranger 4	U.S.A.	Apr. 23, 1962	Atlas-Agena B	Impacted on Moon but cameras and experiments did not operate.
Ranger 5	U.S.A.	Oct. 18, 1962	Atlas-Agena B	Missed Moon by 725 km; ended in solar orbit.
No name	U.S.S.R.	Jan. 4, 1963	A-2-e	Probable lunar probe; failed.

[a]This project was directed by the Advanced Research Projects Agency and launched by the U. S. Air Force. All subsequent U.S. lunar projects were directed by the National Aeronautics and Space Administration.

Name	Country	Launch Date	Vehicle	Remarks
Luna 4	U.S.S.R.	Apr. 2, 1963	A-2-e	Attempted soft landing; missed Moon by 8,500 km; went into barycentric orbit.
Ranger 6	U.S.A.	Jan. 30, 1964	Atlas-Agena B	Impacted on Moon; TV system did not function during approach.
Ranger 7	U.S.A.	July 28, 1964	Atlas-Agena B	1st successful Ranger mission; impacted on Moon after taking 4,308 pictures of lunar surface during approach.
Ranger 8	U.S.A.	Feb. 17, 1965	Atlas-Agena B	Impacted on Moon after 7,137 closeup pictures.
Kosmos 60	U.S.S.R.	Mar. 12, 1965	A-2-e	Probable lunar probe; failed.
Ranger 9	U.S.A.	Mar. 21, 1965	Atlas-Agena B	Impacted in crater Alphonsus after returning 5,814 pictures.
Luna 5	U.S.S.R.	May 9, 1965	A-2-e	Attempted soft landing by U.S.S.R.; impacted on Moon.
Luna 6	U.S.S.R.	June 8, 1965	A-2-e	Attempted soft landing; missed Moon by 161,000 km and went into solar orbit.
Zond 3	U.S.S.R.	July 18, 1965	A-2-e	Transmitted 25 pictures of lunar far side taken during lunar flyby; went into solar orbit.
Luna 7	U.S.S.R.	Oct. 4, 1965	A-2-e	Attempted soft landing; impacted on Moon.
Luna 8	U.S.S.R.	Dec. 3, 1965	A-2-e	Attempted soft landing; impacted on Moon.
Luna 9	U.S.S.R.	Jan. 31, 1966	A-2-e	1st successful soft landing by U.S.S.R.; returned 27 pictures of lunar surface in 3 days.
Kosmos III	U.S.S.R.	Mar. 1, 1966	A-2-e	Suspected lunar probe; failed.
Luna 10	U.S.S.R.	Mar. 31, 1966	A-2-e	Achieved lunar orbit; transmitted physical measurements for nearly 2 months.
Surveyor 1	U.S.A.	May 30, 1966	Atlas-Centaur	Successful soft landing; transmitted 11,237 picures of lunar surface.

Name	Country	Launch Date	Vehicle	Remarks
Explorer 33	U.S.A.	July 1, 1966	Thrust-augmented Delta (TAD)	Attempted lunar orbit not achieved; in barycentric orbit.
Lunar Orbiter 1	U.S.A.	Aug. 10, 1966	Atlas-Agena D	Successful orbital photographic mission; photographed Moon until Aug. 29, 1966; impacted on Moon Oct. 29, 1966.
Luna 11	U.S.S.R.	Aug. 24, 1966	A-2-e	Achieved lunar orbit; transmitted data until Oct. 1, 1966.
Surveyor 2	U.S.A.	Sept. 20, 1966	Atlas-Centaur	Attempted soft landing; impacted southeast of Crater Copernicus.
Luna 12	U.S.S.R.	Oct. 22, 1966	A-2-e	Achieved lunar orbit; transmitted lunar pictures and data.
Lunar Orbiter 2	U.S.A.	Nov. 6, 1966	Atlas-Agena D	After transmitting 422 pictures from orbit, impacted on the Moon.
Luna 13	U.S.S.R.	Dec. 21, 1966	A-2-e	Successful soft landing; transmitted pictures and soil density data.
Lunar Orbiter 3	U.S.A.	Feb. 4, 1967	Atlas-Agena D	After transmitting 307 pictures from orbit, impacted on the Moon.
Surveyor 3	U.S.A.	Apr. 17, 1967	Atlas-Centaur	Successful soft landing; transmitted 6,315 pictures and soil data.
Lunar Orbiter 4	U.S.A.	May 4, 1967	Atlas-Agena D	Photographed all of near side; after returning 326 pictures from orbit, impacted on the Moon.
Surveyor 4	U.S.A.	July 14, 1967	Atlas-Centaur	Impacted on the Moon; experiments did not function.
Explorer 35	U.S.A.	July 19, 1967	TAD	In lunar orbit; measures Earth's magnetic trail every 29.5 days.
Lunar Orbiter 5	U.S.A.	Aug. 1, 1967	Atlas-Agena D	Last of the highly successful Orbiter missons; impacted on the Moon after completing photographic coverage of far side.
Surveyor 5	U.S.A.	Sept. 8, 1967	Atlas-Centaur	Successful soft landing; transmitted 18,006 pictures and chemical analysis of soil.

Name	Country	Launch Date	Vehicle	Remarks
Surveyor 6	U.S.A.	Nov. 7, 1967	Atlas-Centaur	Successful soft landing; transmitted 30,065 pictures and chemical and mechanical solar studies; performed first rocket takeoff on Moon.
Surveyor 7	U.S.A.	Jan. 7, 1968	Atlas-Centaur	Sucessful soft landing; transmitted 21,274 pictures and chemical analysis of soil.
Zond 4	U.S.S.R.	Mar. 2, 1968	D-1-e	Launched into undisclosed trajectory from initial parking orbit; probable precursor to manned lunar mission.
Apollo 6	U.S.A.	Apr. 4, 1968	Saturn V	Failed to reach Moon.
Luna 14	U.S.S.R.	Apr. 7, 1968	A-2-e	In lunar orbit; measuring lunar gravity gravity field and Earth-Moon mass relationship.
Zond 5	U.S.S.R.	Sept. 15, 1968	D-1-e	1st circumlunar mission after which spacecraft returned to Earth; recovered from Indian Ocean, Sept. 21, 1968.
Zond 6	U.S.S.R.	Nov. 10, 1968	D-1-e	2nd unmanned circumlunar mission; spacecraft recovered in U.S.S.R.
Apollo 8	U.S.A.	Dec. 21, 1968	Saturn V	1st manned circumlunar flight; 10 orbits completed; first mission in which true photographs taken from lunar orbit were returned to Earth (Astronauts Borman, Lovell, and Anders).
Apollo 10	U.S.A.	May 18, 1969	Saturn V	LM detached from the CM and piloted to within 14.9 km of the Moon and returned to the CM; first color TV from space (Astronauts Stafford, Young, and Cernan).
Luna 15	U.S.S.R.	July 13, 1969	D-1-e	After completing 52 orbits; impacted on Moon.

CLASSROOM ACTIVITIES AND FIELD TRIPS

There are many possibilities for classroom activities and field trips related to aerospace education. Activities and field trips will be most effective, of course, when they are pertinent to the topic of current study.

Classroom Activities

- Construction of paper sail planes
  - Standard design
  - Experimental design
  - Competition flying
- Construction of model rockets
  - Basic model
  - Advanced models
  - Experimental models
  - Model rocket club competition
- Construction of model airplanes
  - Solid models built to scale
  - Flying models
    - Free flight
    - Control line flight
    - Radio control, single and three-way
- Construction of wind tunnel
- Weather logging, plotting situation maps and forecast maps
- Radio communications with walkie-talkie radios
- Air-navigation game
- Orientation flights
- Link briefing and demonstration flight

Field Trips

- Airport
  - Briefing by manager
  - Control tower
  - Weather bureau
  - Airline(s)
    - Office, ticket counter, baggage, freight, maintenance, kitchens
    - Passenger processing, from reservation by telephone to arrival at destination

Communications center
Aircraft parking
Terminal
Air mail area
Auto parking area

Airline stewardess school

National Aeronautics and Space Administration (NASA) installations

General aviation installations
- Commercial, large or small fixed base operations
- Private

Aerospace industries
- Aircraft and accessories
- Rockets and missiles
- Research and development

Museums

Military air bases and other installations

Federal Aviation Administration Research and Development Training Center

Planetariums

Observatories

EVALUATION SHEET

TO: K-12 Teachers

The State Department of Education would appreciate your help. Please answer the following questions and return this page to the address given below:

Did you find this aerospace guide helpful in your classes?		___yes	___no
With regard to the activities, did you use:	___all	___some	___none
Do you feel the materials in this book are suitable for K-12 classes?		___yes	___no
Do you feel the need for additional training in aerospace education?		___yes	___no

Would you be interested in:

A two day workshop (weekend)	___yes	___no
A three week workshop	___yes	___no
A one day in-service workshop	___yes	___no
Receiving additional teaching aids from the SDE	___yes	___no

Other (please specify) _____

COMMENTS:

MAIL TO: Science Specialist
State Department of Education
Oliver Hodge Bldg.
2500 N. Lincoln Blvd.
Oklahoma City, OK 73105

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